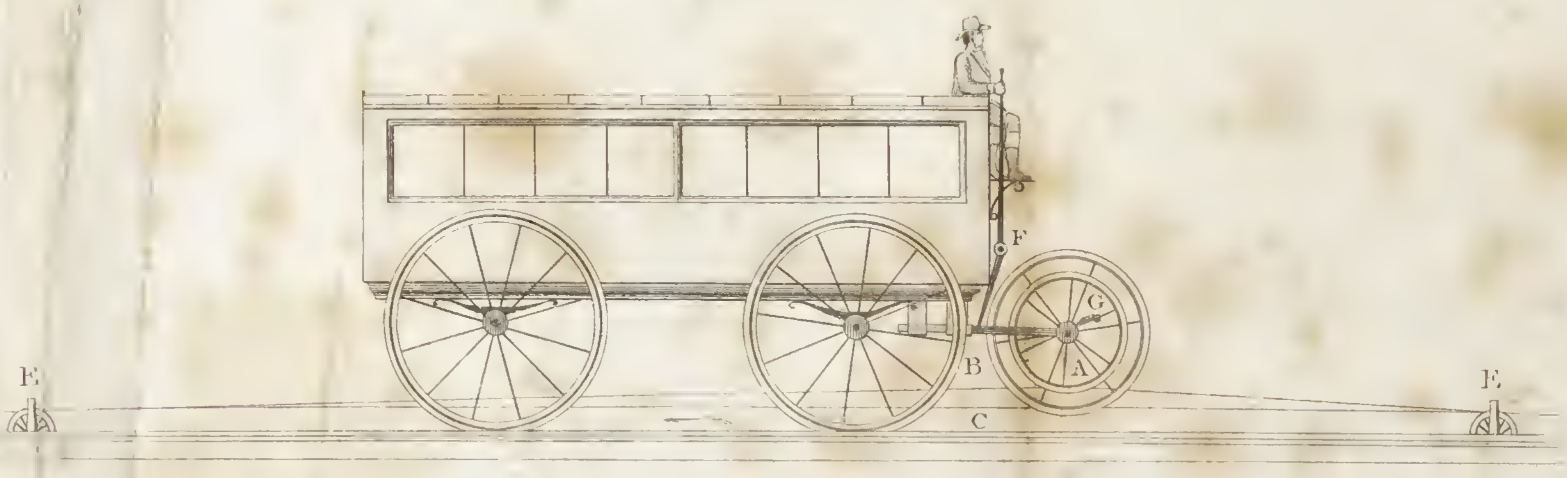
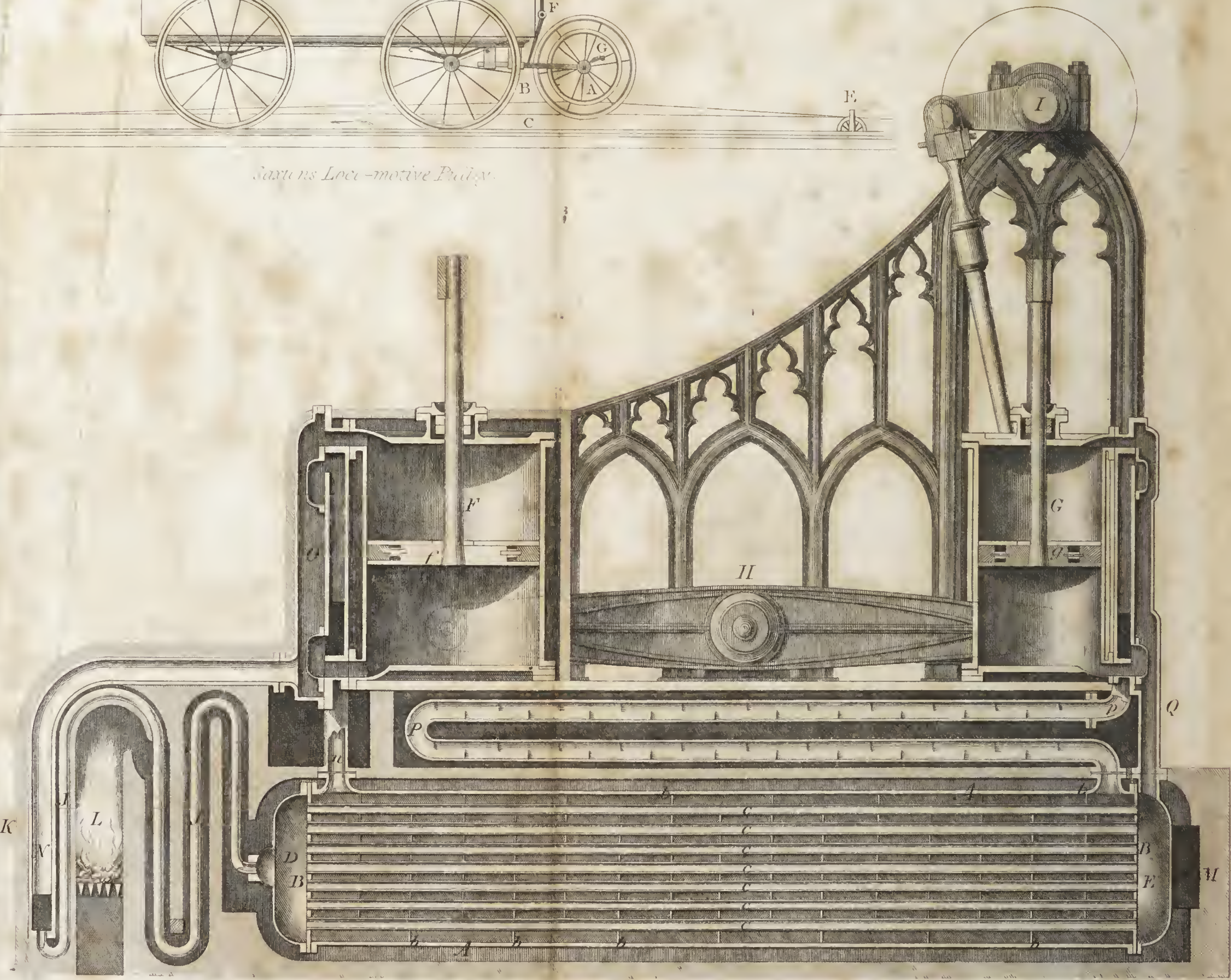



*Saxtons Loco-motive Railway.*



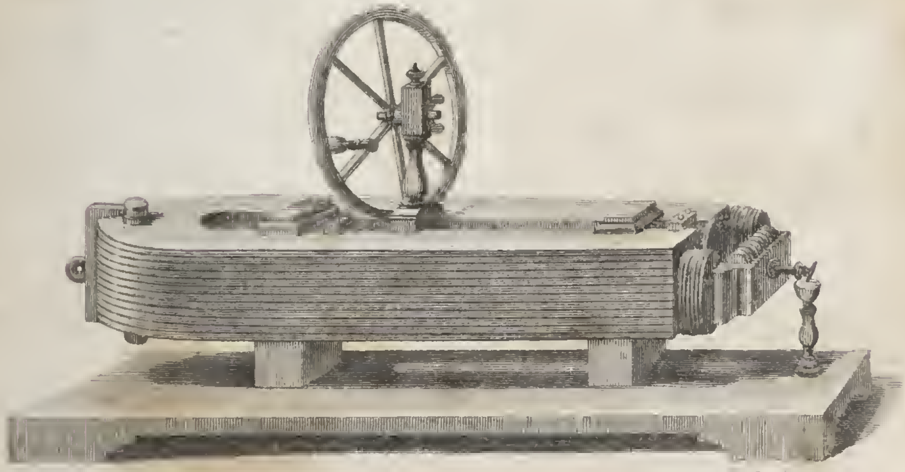

*Ericssons Caloric Engine.*

J. Greig sc.

# A DICTIONARY of the ARTS OF LIFE and CIVILIZATION.

By

*Sir Richard Phillips.*



J. Greig sc.

*Faraday's Magnetico-Electrical Machine.*

LONDON.

SHERWOOD, GILBERT & PIPER.

*Price 14/*

TO

# GEORGE BIRKBECK, Esq. M.D.

PRESIDENT OF THE LONDON MECHANICS' INSTITUTION,

&c. &c.

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Dear Sir,

If you feel surprize at seeing this Volume dedicated to you, the public would have felt more surprize if so obvious a duty had been neglected by the Author.

The first Promoter and efficient Patron of Mechanics' Institutions, as means of general instruction in Arts and Sciences, and of improvements in the moral and social condition of long-neglected classes, merits all the gratitude and all the public distinction which the love of science and a sense of patriotism can bestow.

It is in this sense that the Author takes the liberty to prefix your name to this Volume. At the same time he is not proposing to shelter his errors, either in practice or in reasoning, under the sanction of your authority; for, on subjects of science, and in exertions of reason, he utterly disclaims the influence of any personal authority, as dangerous to intellectual freedom and to truth.

From the Author's intimate knowledge of your character, he draws the conclusion that you, above all men, would most tenaciously assert the rights of intellectual freedom; while the advantages of free enquiry, and the rejection of all opinions not founded on reasonable bases, are mere corollaries.

It is, at the same time, inexpedient that every student, like Descartes, should begin by doubting all that his predecessors had taught; but such ought to be the duty, at least, of those whose ambition stimulates them to the distinction of being leaders of sects and teachers of mankind. Hence, the present Writer has granted no more than in his conscience appeared reasonable; and he has asserted the truth, with fearlessness, on many points in a way which will command your respect, if, in every instance, his arguments do not produce conviction.

Of the utility of such a Volume, no living person will be more sensible than yourself, while no one was so well qualified for the undertaking. Many circumstances must, however, concur to every end; and hence the present Writer has adventured on a task which required fidelity, industry, and common sense—not because he considered himself the best qualified, but because he felt strongly the desirableness of such a work.

For much anxiety that has attended its execution, he is in some degree rewarded by the opportunity which custom affords him of dedicating it to you, for the purpose of publicly testifying his opinion of the obligations of this reforming age to your liberal spirit, and his deep sense of your virtues, as the citizen of a free country, and the amiable father of a happy family.

I am, Dear Sir,

Your earnest and obliged Friend,

R. PHILLIPS.

*Chelsea,*
Dec. 13th, 1833.

# PREFACE.

"The sole purpose of Science, and of all Study, is the Economy and Improvement of the Arts of Life."—*Rumford.*

"Science may be lofty in its pretensions, but its proudest boasts are the Steam of Boiling Water, the Gas of Coals, the Bleaching of Linen, and the Fermentation of Infusions, all derived from practices of the Housewife; but, in reflecting them with improvements from the Laboratory to the Manufactory, the very best service is rendered the Human Race."—*Cuvier.*

"How much useful knowledge is lost by the scattered forms in which it is ushered into the world! How many solitary students spend half their lives in making discoveries, which had been perfected a century before their time, for want of a condensed exhibition of what is known! How much of valuable knowledge is buried and lost in the wildernesses of Books in the great Libraries of Paris, Rome, and London!"—*Buffon.*

"I have often regretted that we have not such a Dictionary of the Chemical, Mechanical, and useful Arts, practised in civilized Society, as would enable a willing Savage, or a barbarous People, at once to profit by all our Discoveries."—*Franklin.*

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THE preceding mottoes justify the composition and publication of this volume.

When it appears, and is candidly examined, it will be matter of wonder that no such work had hitherto existed in modern literature. In England, especially, we are mingled more with the useful arts than any other people, yet no one has assembled their details and most-approved processes and manipulations, in any book adapted by bulk and price to general use.

We have the volumes of Salmon and Smith, but they are works which have now become quite obsolete; and we have Imison's School of Arts, but the three were produced before the CHEMICAL ERA, which, referring to elements and first principles, has simplified and shortened every process.

The only existing book, comparable with the present volume, is the Five Thousand Receipts, published under the name of Mackenzie, and it is a valuable volume; but something more than mere receipts has been properly required; and an account of the substances, and of the theory of their combinations was wanted, as well as mere receipts for compounding them. Besides, in the accelerated advance of improvement, the short period of ten years since that useful book was prepared has been an age of scientific revolution.

On particular subjects, also, we have had excellent books; but, to possess all these, requires a formal and expensive library; and, to study them, more time than can be spared by practical men, or, by others, who have little taste for elaborate research. In Pharmacy, nothing can surpass the volumes of Gray, Thomson, and Paris. In Chemistry, we have Nicholson, Accum, Ure, and Thomson. In Mechanics, Gregory, Nicholson, Buchanan, and Brunton; but, on manufacturing operations, no separate work. The void is in some degree filled up, by articles in ponderous Cyclopædias, but the forbidding bulk, and high price of these, exclude the mass of curious enquirers.

There was room, therefore, for such a volume as that now printed; and there can, therefore, be little doubt but it will meet with distinguished success.

The Author, in early life, acquired a taste for such subjects, in a great London Brewery, which carried mill-work, machinery, &c. and the arts of fermentation, to their limit. Since that time, he has lived among manufacturers and men of business; and, during many years, in his own literary Journal, had much intercourse with patentees, and men of science. Latterly, he made a tour through Leicestershire, Nottinghamshire, Derbyshire, Yorkshire, Lancashire, Cheshire, Staffordshire, and Warwickshire, and had such access to all manufactories as prepared his mind for the present undertaking.

He has, besides, derived information from our trans-atlantic rivals in Arts and Industry, among whom, ingenuity is making rapid and wonderful strides; and he has availed himself of much original information in the American Cyclopædia, and in books published in that thriving country, on many isolated subjects.

Whatever may be the merits of the work, it is, at least, devoid of ostentation. It is an unpretending assemblage of the most useful of all matter—and it is so printed as to exhibit the greatest possible quantity, in the least room, and at the least cost.

The value, importance, and novelty of this volume, can be duly appreciated only by comparison with all former books of like kind. Nor does the difference arise from the superior industry of the present Editor, but from the astonishing advance of every human art within the last sixty, or even thirty or twenty years. Chemistry, and all its collateral arts, have rendered obsolete the best receipts of forty years ago; not merely in manipulations and composition, but in exhibition and theory.

Any former work, of this nature, now requires a Glossary, something like those to the Poems of Chaucer, independently of the obsolete and superseded principles. It is, therefore, the design of this volume, to accommodate practice to the actual state of knowledge, and to the enlightened principles and correct nomenclature of the present period. If the Editor has but moderately succeeded in executing his own plan, he has produced a book of inappreciable convenience and worth, which cannot fail to challenge the attention and curiosity of the intelligent of all classes, from the workshop to the saloon, and from the kitchen to the boudoir of taste and fashion.

In general, theory has not been obtruded; and, in all cases, only incidentally, and with reference to deep-rooted and flagrant errors. A practical work was wanted, and such a one it has been the object to compose. Its utility will compensate for the dullness of details; and those who seek use or value in such a volume, will not be disappointed by the omission of appeals to the imagination.

The same inflexible adherence to processes and manipulations has excluded statistical details, for which the Author may, without impropriety, refer to his Million of Facts, which is expressly devoted to the statistics and arithmetic of knowledge. In this way the two works will aid each other, but without any interference or intended connection. One is a simple enunciation of facts and truths, without processes and manipulations; and the present work is strictly a description of processes and manipulations. They are two distinct noun-substantives, standing alone, and independent of each other.

All Metals and Minerals are generally described, which are useful in the arts directly or indirectly, or likely to become so.

Vegetables, useful in the arts of medicine, or as food, have been sufficiently enlarged upon.

Without being either anatomical or physiological, the important parts of animal organizations have been succinctly described; and, without being medical, those diseases which mostly afflict mankind have been noticed, chiefly with a view to prevention and relief.

Chemistry, the basis of so many arts, has come in for its full share of notice; and an endeavour at the same time has been made, to simplify its principles. Hundreds of processes and manipulations have been introduced, in such manner as will enable every patient experimenter to repeat them. It was, however, impossible to pursue this science in all the combinations of elements, with all bases in acids and salts, the chief part of which are mere varieties of scientific manipulation, and speculative combination.

In Arithmetic, and in practical mathematics, every thing has been simplified, and many applications of figures to the arts have been divested of their previous complexity.

For several able articles relative to Pottery, the Blow-pipe, &c. the Editor is indebted to his ingenious friend, DR. SIMEON SHAW, of Shelton, in the Potteries. It too often happens, that able manufacturers are not writers; and, hence, the literature of the arts has been at so low an ebb. We hope, however, that this more active work will lead all who may regret misinformation, to enable the Author to enlighten the public, in the successive editions which it may be expected will be demanded of such a volume.

For some deviations from authority, the Editor, in this enquiring and self-thinking age, scarcely need to apologize. Authority has weight only in the precincts of endowed schools, where professors are paid for submission, and are expected to submit; but, in the great school of Society, authority has no weight, except that degree which it derives from its obvious association with common sense. As men reason only from what they know, and as education is directed by the aged or the knowing of each past age, so it unhappily results, that a continued warfare exists between the originality of one age and the prejudices of the last ; and, therefore, mankind are encircled by errors, of which few have the courage to pass the bounds.

In the year 1834, we are on the EVE of great discoveries. The execrable nonsense propagated and perpetuated by the schools on the authority of ages of superstition, and which have been fetters on the energies of practical talent, and the free application of the legitimate powers of nature, are gradually losing their influence over the deductions of independent reason. Within a few years, science will cease to be obstructed and mystified by absurd dogmas, about such powers, *sui generis*, as attraction, repulsion, elasticity, gravitation, caloric, fluids, *per se*, and the like ; all which, yielding like suction, &c. to the analyses of their *modus operandi*, will be superceded by the universal principle of mechanical ACTION and REACTION. This triumph of mind over the waste-paper of books, and over pretended and craftily-obtruded bodies of knowledge, is, in our own day, displayed by advances in mechanical and physical science, which are at once as astonishing and delightful as useful and promising. We may therefore expect, that, in a few years, the civilised world will present a *Spectacle* of improvements in the application of true science, such as never could have been anticipated from our past thraldom, under the despotism of the schools, and interested book-makers.

In the consideration of the means of accelerating the improvements of Society, the Editor is led to conclude, that incalculable advantages would result, if, by a well-arranged system, public funds were applied or annuities granted for the purchase of inventions for the public benefit; or public capital advanced, on fair interest and security, to inventors, to enable them to give effect to approved inventions. Nine-tenths of the inventions now patented are not rendered available, by the poverty which usually accompanies Genius and a life of study; or, if capital is obtained from private funds, it is on terms which rob the real inventors of all the benefit.

Again, improvements are obstructed, and important discoveries often withheld, owing to there being no provision for the operatives thrown out of employment by their introduction. This is a desideratum of the first importance to improvement. Prosperity and contentment cannot move in unison in any country, till a liberal system of this kind is established. It may be open to abuse, but it would be more wise and just to submit to many abuses, than that a single family should be destroyed, which, for generations, had subsisted by any course of ingenious industry. A benefit to the public, from inventions advantageous to the public, ought never to be accepted, by the sacrifice of any portion of the population, however few in number, or humble in condition.

Another desirable improvement of Society is the establishment of a system of social rewards and distinctions, to persons of mature age, for blameless lives passed in useful and meritorious pursuits, either public or local. Wisdom demands, that if we punish vice and crime, we ought to reward virtue and useful industry. Codes of punishments and codes of rewards ought to run parallel; and, if we appeal to the mere consciousness of rectitude in one case, we ought, by parity of reasoning, to trust to reproaches of conscience in the other. But, as governments put no such trust in one case, so they are bound not to trust to it in reward of virtue; but men in society, as in all schools, should have held up to them parallel codes of rewards and of punishments. As society is now constituted, its distinctions are conferred almost entirely on wealth; while accumulations of wealth are no tests of virtue, but too commonly are results of the success of passions, which merit no distinction. On this subject, the higher authority and emphatic language of the New Testament need not be quoted. Twice the cost of the existing system of punishing crimes would be a cheap price for encouraging, by positive provisions, the counter-energies of social virtue.

These suggestions may not be the common-place business of a Preface, but, as they are results of the Author's observations on some radical faults of Society, he should have failed in his sense of duty if he had suppressed them. This age may not witness their adoption, but good seed, sown even in barren soils, in due time seldom fails to produce fruit.

From the nature of the work, and the multiplicity and varied character of its contents, some errors of the press, and even in combining various authorities, must have been unavoidable. For such, the Editor craves the indulgence of his candid readers. In receipts, he has generally given duplicates or triplicates, by which an error in one may be corrected by another. Brevity, too, has often obliged him to generalize, while fulness would have enabled him to give all the exceptions, but his object has been to make the most of his space.

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In confirmation of some of the preceding observations, the Author may quote some valuable discoveries, which have been announced at the time when he was closing his labours on this work; and he has, in fact, deemed them so important, as to resolve to become their harbinger to public notice in an engraving.

The *first* is, ERICSSON'S application of excited or rarefied air to the performance of those powers of machinery, which, hitherto, have been made to depend on the intervention of boiling-water and its steam. The Author has, with inexpressible delight, seen the first model-machine, of five-horse power, at work. With a handful of fuel applied to the very sensible medium of atmospheric air, and a most ingenious disposition of its differential powers, he beheld a resulting action in narrow compass, capable of extension to as great forces as ever can be wielded or used by man. Perhaps this is as close a junction as we may ever be able to form between the force of the oxygen transferred to the fuel in burning, and the effect or working result. In transmitting this force through water, and forming steam, we probably waste a 10th, or even a 5th, independently of the cumbrous and dangerous character of the operation.

The *second* is a visual proof of the connection of magnetism and electricity. For, as magnets may be made by electrical action at right angles, it seemed reasonable that magnets should reciprocally produce electricity at right angles. But, as the laminæ of iron, which generate its galvanic series (so to speak) are so close as to afford no sensible spark in restoration, a circular transferrer of the positive and negative of the poles has been invented by Dr. Farady, and then, by separation and by reunion at the poles, the oxygen and nitrogen elements produce their usual light and heat.

The *third* is a *Differential Pulley*, invented by SAXTON, the same ingenious person who applied the rotatory transferrer to the magnet. By this instrument, local power may be so extended lengthways, as to become a practical auxiliary in the loco-motion of carriages, for travelling and conveyance, and, there is reason to believe that it will soon be so applied.

The following details will justify the preference of these subjects in the frontispiece, independently of their mere novelty.

## I.

## ERICSSON'S CALORIC, OR RAREFIED AIR-ENGINE.

The accompanying drawing of the caloric-engine has been purposely so arranged as to give a distinct idea of its construction in one view ;—for, the proper place for the regenerator would evidently be by the side of the engine. A is the regenerator, consisting of a cylindrical vessel, closed at the ends by the plates BB ; through these plates a number of small tubes, C, pass from end to end, terminating in the caps D and E, thus forming a free communication between them, but not communicating with the body of the regenerator. A number of division plates, *b*, divide the regenerator into as many chambers, and these are made to communicate with each other, by segments being cut out alternately from the tops and bottoms of the division plates. The tubes, C, are also provided with division plates, or small metallic discs, placed in opposite directions to each other. F is the working-cylinder of the engine, called the hot-cylinder. G is a smaller cylinder, called the cold-cylinder, which receives the air that escapes from the former, and then forces it back again, for every stroke of the piston, thereby keeping up a constant circulation of the impelling medium and promoting a constant transfer of heat. The pistons of the two cylinders are connected by a beam, H, side-rods, and cross-heads, similar to a common marine-engine, and the cylinders are provided with slide-valves nearly of the common construction, marked by suitable gear from eccentrics fixed on the crank-shaft, I.

J is one of a series of pipes inclosed in a stove, K, acted upon by a fire, L, the combustion being supported by ordinary draught, caused to circulate round the regenerator, and passing off from M into a chimney. The pipes, J, in the stove, all terminate at one end, in the cap D, and at the other end in the pipe N, which communicates with the slide-box, O, of the hot-cylinder. P represents a cooler, and consists of one or more pipes, exposed to some cooling medium, these being like the longitudinal pipes in the regenerator, provided with a number of metallic discs.

Previous to describing the action of the engine, let us suppose that the stove, with its pipes and the working-cylinder, have been brought to some considerable temperature, and likewise the regenerator with its tubes brought to the same temperature nearest to the stove, gradually lessening so as to be, at the opposite end, equal in temperature with the surrounding atmosphere. By examining the positions of the slide-valves, as represented in the drawing, it becomes evident that if air be, by some means, forced or pumped into the caps of the regenerator, such air will on the one hand find its way through the stove-pipes, &c. into the *top-part* of the hot-cylinder, and, on the other hand, through the connecting-pipe, Q, into the *top-part* of the cold-cylinder. Now, since the hot-cylinder is larger, say double the size of the cold-cylinder, it follows that the power of the piston, f, will vanquish the power of the piston, g, and make it *ascend*, at the same time itself *descending;* thus motion will be produced, and the crank-shaft begin to revolve, and, by reversing the position of the slide-valves, when the pistons have performed their full strokes, that motion will be continued.

By further examining the drawing, it will be seen that the cold-cylinder receives its supply of air from the *body* of the regenerator through the cooler, P, and the pipe, p, entering *under* the slide-valves; it will also be seen that the hot-air from the hot-cylinder escapes under the slide-valves, through the pipe, n, into the body of the regenerator,—hence the same air that escapes from the hot-cylinder supplies the cold one. In like manner it will be found, by referring to the drawing, that the air forced from the cold-cylinder into the cap, E, must pass through the pipes of the regenerator, stove-pipes, &c. to supply the hot-cylinder.

From what has been already said, the action of the engine, and the transfer of the heat become almost self-evident; it need, therefore, only be briefly stated, that the hot-air in escaping from the hot-cylinder will, during its passage through the body of the regenerator, give out its heat to the tubes, C, being, by the peculiar arrangement of the division plates, *b*, compelled to ply round those tubes. And the cold-air, coming from the cold-cylinder, will in its passage through the tubes, C, naturally take up the heat imparted to them, its particles being kept in a constant state of change by the small metallic discs. A transfer of heat being thus effected, it becomes evident, that the office of the cooler will be that of carrying away any heat from the air which has not been taken up in the regenerator, and that the office of the stove will be to give an additional quantity of heat to the circulating air, previous to its entering the hot-cylinder, in order to make up for a small deficiency which will always be unavoidable in the transferring process, besides the losses caused by radiation.

The power of the engine will mainly depend on the density of the circulating medium; accordingly, by having a small pump attached to the engine, the power and pressure may be varied at pleasure. High pressure will, of course, produce the greatest proportionate effect; since the losses, by radiation, will remain the same under whatever pressure.

The trial-engine, which has been erected by the inventor, and the action of which has been found in every respect satisfactory, may be fairly estimated at five horses' power; it makes fifty-six revolutions per minute, having a break-wheel fixed on the fly-wheel shaft, loaded with upwards of five thousand pounds weight. The working-cylinder is fourteen inches in diameter, and the cold-cylinder ten and a quarter inches in diameter, both making eighteen inches stroke, working under a pressure of thirty-five pounds to the square inch.

The regenerator, in this trial-engine, is eight inches and a half in diameter, and seven feet six inches long, containing seven tubes, of two inches diameter each; and its operation is so perfect, that all the heat lost, that is, heat not returned to the engine, does not amount to more than three pounds of fuel per hour. The total consumption of fuel is, however, nearly two pounds per horse-power in the hour, owing to the great radiating surfaces unavoidable in an engine on a small scale, while these surfaces have not, in this first instance, been properly protected by any imperfect conductors.

*The principle of this new engine consists in this, that the heat which is required to give motion to the engine at the commencement, is returned by a peculiar process of transfer, and thereby made to act over and over again, instead of being, as in the steam-engine, thrown into a condenser, or into the atmosphere as so much waste fuel. And the well-known phenomenon that temperature, or quality of heat, is always equalized between substances, however unequal they may be in density, forms the basis of this new application of heat. The most accurate experiments prove, that the combustion of one pound of the best coal is only capable of raising the temperature of* 9000 *lbs. of water one degree. So that an engine, in giving motion to the shaft of a mill, will consume from* $7\frac{1}{2}$ *to* 8 *lbs. of fuel in the hour for every horse's power constantly imparted to that shaft.*

## II.

## MAGNETIC ELECTRICAL MACHINE.

A powerful magnet, of tempered steel, for illustrating, on a splendid and extensive scale, Magneto-Electrical Phenomena.

This magnet (arranged by Mr. Joseph Saxton, expressly for exhibition) fully demonstrates Dr. Farady's great discovery of the apparent identity of the electric and magnetic fluids. It is of the horse-shoe form, and composed of twelve shear-steel plates, in close approximation.

The armature is formed of a bar of the purest soft iron, having each of its ends bent at right angles, so that the faces of those ends may be brought directly opposite to the poles of the magnet, as the case requires.

A series of copper wires, covered with silk (for the purpose of insulation) are wound around the armature, as compound helices, in order to concentrate the magneto-electricity induced upon the wires by the armature.

The armature is itself rendered a temporary magnet, by the inducing effects of the permanent steel-magnet, so long as its faces are opposed to those of the magnet; and its precise polarity is dependant on the common law of induction.

All the extremities of the copper helices, having the same direction, are in metallic connexion with the circular disc, which dips into the mercury contained in the capsule; while the extremities of the wires in the opposite direction are soldered to a projecting screwed piece, which carries the small slip of copper, whose points alternately dip into the mercury and leave its surface, as the armature rotates.

The armature is furnished with a horizontal axis, that passes half through that of the magnet, having a metal pulley affixed to its outer end. A multiplying-wheel is provided, the band of which passes, also, over this pulley; by which means a continued and rapid curvilinear motion may be communicated to the armature, by turning the wheel. Now, as every time the faces of the armature change their position, in respect to the poles of the magnet, so, also, does the polarity of the armature vary; this again affects the magneto-electrical condition of the helices of copper wire, which alteration of condition is made manifest, by the developement of electrical effects, differing in amount as the rotatory process is more or less rapid.

The magnet, above described, is capable of producing a succession of the most brilliant sparks, and of communicating very powerful shocks, which, like those afforded by electrical machines, may be passed through the bodies of several people at the same instant. It is also capable of heating a platinum wire red-hot, and of deflagrating the wires of other metals.

The exhibition of this triumph of science takes place at stated periods of the day, at the Mechanical Gallery, in Adelaide-street; where are also to be seen an astonishing display of mechanical and economical inventions:—as Perkins' Steam-Gun, his Steam-Boat Paddles; Saxton's Differential Pulley; Nutt's Invaluable Bee-Hives, &c. &c.

The idea of producing a reciprocal current of electricity from magnets in tangents, or at right angles, was Dr. Farady's, and he prosecuted a series of very difficult experiments, till he realized the object. M. Fixé, of Paris, then extended the principle by rotating the magnets; but, Mr. Saxton gave the discovery its present practical character, by revolving the armature. It is the germ of many important applications, and of much improved intelligence on these hitherto mysterious and mystified subjects. This age scarcely expected so rapid an advance, when Professor Œrsted, but twenty years ago, announced the production of magnets, by the tangential or right-angled action of electrical currents. The machine is made in its best form, by Watkins and Hill, of Charing-Cross.

## III.

## SAXTON'S LOCO-MOTIVE, OR DIFFERENTIAL PULLEY.

This simple contrivance is considered, by many mechanics, as a convenient practical means of accelerating speed in travelling, by power comparatively small, stationed in the line of progress. It is conceived, for example, that the power of one horse may thus accelerate travelling-carriages thirty miles an hour on light and cheap rail-ways.

A, the pulley attached to the carriage, by the supports 1 and 2. B and C, the endless cord passing round the rigger, D, and each strand makes a turn round each groove in the pulley, the strand B round the small, and C round the large groove. EE, the double sheaves, for supporting the cord off the ground. F, the lever, by which the conductor acts on the clutch at G, for separating the pulley when he wishes to stop the carriage, or to connect them when he is ready to start. The proportion in this pulley is drawn as 6 to 8, so that if the strand C is pulled in the direction of the arrow one foot, the carriage will move in the opposite direction fourteen feet, the motion of the cord always being as the difference between the diameters of the grooves in the pulley, and the motion of the carriage equal to the sum of both diameters.

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# DICTIONARY

OF

# THE ARTS OF LIFE.

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ABDOMEN, or BELLY, is the cavity of an animal in which most of its vital functions are performed. The animal body is divided by anatomists into three portions, the *head*, the *trunk*, and the *extremities*. The trunk forms two cavities, the upper of which is termed the *Thorax* or Chest, and the lower constitutes the *Abdomen*, or belly.

The partition is an organ termed the Diaphragm, which is composed partly of membrane, but chiefly of muscle. It is placed transversely across the trunk at about its middle portion, dividing it into two nearly equal parts. But the Diaphragm is itself a moveable body; and in fact one of the main organs of respiration. Its chief function consists in *alternately increasing and diminishing* the capacities of the thorax and the abdomen.

The cavity of the Abdomen is, therefore, bounded above by the diaphragm, below by the bones of the pelvis or basin, which may be considered as belonging to the bones of the lower extremities; *before and at the sides* by muscles, *behind* partly by the muscles of the loins, and partly by the bone of the spine, or back-bone, termed by anatomists the spinal or the vertebral column.

The entire cavity of the abdomen is lined throughout by a thin, but dense, firm, and strong membrane, termed the PERITONEUM.

During life there is no cavity in the abdomen, and it is always completely full. The diaphragm *alternately* enlarges and diminishes the space proper to the abdomen; but the muscles which form so large a part of the boundaries of the abdomen, in like manner *alternately* contract and relax. In consequence a firm and uniform pressure is at all times maintained on the contents of the abdomen, so that there is the most exact adaptation of the containing to the contained parts, and of the viscera one to the other, not the slightest space or cavity ever intervening either between the sides of the abdomen and its contents.

The whole extent of the abdomen is divided, by anatomists, into regions. Two imaginary lines are imagined to be drawn across the abdomen, one of which is supposed to extend from about the seventh rib on one side, to the same point on the opposite side. The second line is imagined to extend from the fore part of the large bone of the pelvis, to the same projecting point on the other side. The space above the upper line is termed the EPIGASTRIC REGION, or pit of the stomach. The space *below* the lower line is termed the HYPOGASTRIC REGION. The space included between the two lines is termed the UMBILICAL REGION, in which is the naval. Two lines are next supposed to extend vertically, one on each side, from between the seventh rib to the prominence formed by the large bone of the pelvis. By these vertical lines, the three first regions are still further subdivided in the following manner:—The right and left parts of the Epigastric region form two distinct regions termed the right and left HYPOCHONDRIAC. In like manner the right and left parts of the umbilical region form the LUMBAR REGIONS. And the right and left parts of the hypogastric regions are termed the ILIAC REGIONS, and the central part is called the REGION OF THE PUBIS. This map being understood, it will be easy to speak with precision of the situation of any of the abdominal viscera.

ABROMA AUGUSTA, is the Linnæan name for a plant which yields fine Indian flax. It is indigenous in the Philippines, New South Wales, and Australasia, and lately has become a valuable article of import. Roxburgh describes it fully in the Transactions of the Society of Arts for 1804.

ABSENTEES, are persons who live on rents or profits in one country, while they draw their resources from another; and, at the same time, diminish the capital of the country from which they derive their revenue. Rent, interest, &c. become circulation, when received and spent on the spot, but it is abstraction and impoverishment, when withdrawn and spent elsewhere. It can only be paid by carrying the produce off the soil, or by exporting produce to meet the foreign demand, and for this drain there is no return if the amounts of sales are spent and consumed out of the country. Any country, by such a system generally practised, would be utterly impoverished in a few years, and if the system exist in degree, in the same degree is the abstraction or impoverishment. Ireland, for example, is cursed with absentee proprietary, who annually draw off large proportions of the products of its industry and spend the same elsewhere; and England and Scotland, in degree, suffer from the too general absence of landlords from their estates, the original rent of land being in mere produce, and that, in general, being consumed on the spot. The evils of Absenteeism need not have been enlarged upon, but a few years ago a public writer was profligate enough to become the advocate of the system as a public benefit!

ABSORPTION, in animals, vegetables, minerals and machines, is the important result of the pressure of the elastic atmosphere, or any elastic gas, on the whole surface of any fluid, by which it is forced into adjacent pores and capillary tubes. Superstitious writers often treat of it as a natural principle or appetite; but since Torricelli discovered the mechanical cause of suction, absorption has been properly referred to a similar mechanical action. Thus a sponge, sugar, and chalk, are made to absorb water, and the animal lympatics and pores absorb the fluids and gases near the mouths of the vessels. When gases absorb each other, it is to be inferred that the elasticity of the gas absorbed is greater than that of the absorbent. When fluids absorb each other, it arises from one being more fluid or less viscid than the other; and when floating bodies go together, it arises from each of them intercepting the elastic pressure of the air on the other. The elastic pressure itself arises from all gases consisting of atoms moving in orbits, owing to the re-action of the general plenum of gases. In the air it is 15 lbs. to the square inch, such as makes a barometer tube absorb from 28 to 30 inches of mercury, or a pump cylinder absorbs 34 feet of water. Absorption is, in fact, the very same effect as suction and capillary attraction, and they arise from exactly similar causes and combinations, all being to be considered as effects and terms of passive signification with relation to the active cause, elasticity, or elastic pressure.

Garden mould absorbs 95° of moisture, pipe-clay 85°, powdered trap 80°, alumina 84°, silica 40°, wool 18°, down 16°.

At 60° 100 parts of water absorb 400 nitrate of lime, 200 muriate of lime, 150 arsenic acid and muriate of strontites, 133 citric acid. And *equal* weights of acetate of potash, muriate and nitrate of magnesia, nitrate of strontites, sulphate of magnesia, and sulphites of ammonia and potash.

ABSTINENCE, is a remedy for many diseases, especially of the inflammatory kind, and so salutary and necessary that most religions prescribe it every third or fourth day. Nothing contributes more to health and long life than frequent abstinence, especially from all animal food. The Catholic ascetics, and the Mahomedan dervises have mostly attained the age of 90 or 100. Constant gorging wears out the machine, and brings on premature decay and old age, while it aggravates every incidental malady.

ABUTTING JOINT, in carpentry, is when the fibres of the wood meet at right angles. A longitudinal joint is when the fibres are in the same direction.

ACACIA CATECHU, a tree about 12 feet high, and 1 in diameter, which flourishes in the northern mountains of India, and is remarkable for producing the substance called *terra japonica* in Europe, and in India *cutt*. It is a very powerful astringent in many diseases and local affections; but its principal use is in tanning leather, in which 1 lb. goes as far as 7 or 8 lbs. of oak bark. 200 grains of the best, or dark kinds, contain 109 of the tanning principle, and other kinds 97. The alkaline salts destroy its astringency. Among the Hindoos it is part of their betel, and is the base of an ointment for ulcers, mixed with alum, resin, and oil. It is imported in small cakes of red-ochre, or rusty-chocolate colour, brittle, and in laminæ. It is reported to be a preparation from the inner wood of this species of Acacia, which is cut into chips, and these, being boiled, are placed in the sun, and spread on a mat impregnated with cow-dung till dry.

Acacia, *Egyptian Thorn*, or *Binding Bean-tree*, in the Linnæan system a species of *mimosa*. The flowers of this plant are used, by the Chinese, to produce that yellow colour which we see in their silks and stuffs. They make a decoction of the dried flowers, and add alum and calcined oyster-shells.

In the materia medica, Acacia is the

inspissated juice of the unripe pods of the *mimosa nilotica* of Linnæus.

Acacia gummi is another important tree of this species, producing the gum called *Gum Arabic*, but, in fact, brought to us from Barbary, and there from the Mountains of Biledulgered. It is a mean-looking tree, and the gum is a natural exudation from the bark and branches, at first fluid, but inspissated in the sun and air. Dry summers are most productive, and sickly trees produce the most. It converts sulphuric acid into acetic acid, and nitric into oxalic, and malic and chlorine into citric. It is important as a vehicle, in medicine and in various arts. Its components are oxygen 51·546, carbon 41·752, and hydrogen 6·792.

*Emulsion of Gum Arabic* is made by mixing 4 oz. of the gum mucilage, 2 of almonds blanched and beat, with 1 of sugar, with 2 quarts of water, and then straining.

ACAPUNCTURATION, is the protrusion or delicate screwing a fine needle into any diseased, inflamed, or painful part of the body. It is an ancient practice of the Chinese and Japanese, and has been found very beneficial in Europe, in rheumatism, lumbago, face-ache, gum-boils, &c.

ACETATE OF POTASS, is a compound so deliquescent that 100 parts dissolve in 105 of water. It is 48 potash and 50 acetic acid. Every acid and neutral salt decomposes it. In doses from 10 scruples to a grain, it is usefully diuretic, but from 2 to 3 grains is cathartic.

ACETIC ACID, consists of 4 carbon, 3 oxygen, and 2 hydrogen. Equivalent number 50. When in crystals it has 1 water and is 59. It is made by uniting 100 of acetate of potass and 52 of sulphuric acid, by gradually adding the acetate to it. The mixture is then to be slowly distilled. The specific gravity is 1·074. This acid is also produced in much greater concentration by slowly distilling 16 oz. of dry sulphate of iron with 10 oz. of acetate of lead. It is employed to sprinkle apartments and in smelling-bottles. Also for the removal of warts and corns, for blisters, and to produce counter irritation.

Farady directs equal quantities of the acetate of potash and sulphuric acid, with a fourth of the whole of distilled water, in the receiver.

White acetic acid may be made by slowly distilling ten parts of vinegar, and throwing away the first five parts that come over. Glass vessels should be used, as metals, &c. unite with the acid. This is very similar to distilled vinegar; but in this last the first eight parts are taken, and the residue of foreign substances rejected.

The strength of acetic acid is determined by the weight of chalk or marble, which neutralizes it.

Acetic acid *from Wood* is a production of the distillation of woods not resinous. The process is carried on in iron retorts, and the acid, in a gaseous form, is conducted through pipes or worms, kept cold, by which it is condensed. By standing, it precipitates its tar, &c. when it is distilled again, and saturated with lime. A decomposition, by sulphuric acid, is then effected; and, in a third distillation, the acetic acid rises, leaving the sulphate of lime. By recent modes of purification, the tarry flavour is removed, and, with dilution, it is now the best vinegar for family and medical use, especially for various purposes in the arts, since it is supplied of any desirable strength. Glauber wrote at large upon it, but it had been neglected.

*Aromatic Vinegar*, is a solution in acetic acid, at 68, of camphor, oil of cloves, and any other fragrant oils. Or mix six ounces of strong acetic acid with one ounce of compound camphor liniment.

*Lowitz's Acetic Acid.* Dilute 6 oz. of sulphuric acid and 12 oz. of sulphate of potash, with 18 oz. of distilled water, and evaporate to dryness; add 9 oz. of acetate of soda, and ½ oz. of black oxide of manganese fine in powder, and distil in glass, in sand.

ACETATE OF ALUMINE, is prepared in large quantities for calico printers, generally by pouring a solution of 70 pounds of potash alum into a solution of 100 pounds of sugar of lead, and decanting off the liquid portion; or it is sometimes prepared for inferior work, by adding a saturated solution of quick lime in pyroligneous acid, so diluted with water as to have the specific gravity of about 1·05, to a solution of alum, in the proportion of four gallons of the acetate of lime-water to each eleven pounds of alum employed; and separating the sulphate of lime that falls down, by straining off the liquor. Acetate of alumine is employed instead of alum, as a preferable preparation in dyeing and calico-printing.

ACHROMATIC TELESCOPES, or oblique refraction without colour, are founded on the different dispersive powers of prisms of flint and crown glass, by combining which, in the proportion of nearly two to three, the aberration which causes colour in one is corrected by the equal difference of dispersion in the other. A convex lens of crown glass and a concave one of flint, united as one glass, are therefore the object-lens of an achromatic telescope. To correct the aberration of circular form, as well as colour, three lenses are used instead of two, and each surface has a different convexity. The invention was made by Mr. C. M. Hall of Essex, but perfected by Peter Dolland, the optician. The glasses of this construction are, however, now made at Sheffield, Birmingham, and other places where working opticians reside. In a 30-inch glass, the specific gravity of the flint glass being 3·354, and the ratio of refraction of crown to the flint as 1 to 1·656, the radius of curvature of one glass is 8 and 14·3 inches, and of the other 12·11 and 28·5 inc. The simplest form of Dolland's object-glass was a semi-convex crown glass lens with a curvature of seven, placed before a semi-concave of flint glass, with a curvature of four. When three glasses are used, the double concave flint is placed in the middle, whose radii are 22·2 and 30·6, and two double convex of crown, whose radii are 32·4 and 40·8, and 30·6 and 33·3.

ACID, ACIDULOUS, ACETOUS, or ACETIC, are words which express that power of bodies, as fluids or gases, by which they have a sour taste, and exhibit peculiar actions and re-actions on bodies not acid. Of course, acidity is an effect measured by the relations of one atomic action to another atomic action. The sourness is in the Sense, which the acid affects in a particular manner; and the action of an acid on other bodies arises from their own peculiar re-actions. The powers of acidity are destroyed when the acid is suitably combined with an alkali, and the result so harmonizes with the sense of taste as to prove that the sense of taste itself arises from a similar union. Corrosion of bodies by acids is merely the effect of the union of the acid with the substance; but the precise effect being known beforehand, we thus apply acids to effect a great variety of purposes and changes.

In truth, the principle of activity in nature appears to be the principle of acidity in some of its forms or combinations. Its antagonist, or re-agent, is the principle or inverse power of alkalinity, and the strength of acids has usually been determined by the quantity of potash which neutralise the same weight of various acids. Its own purest common form is as oxygen, or vital air, which many chemists consider as the principle of acidity, and the source of all its phenomena; while the purest form of alkalinity is, by Berthollet and others, considered as hydrogen, and potassium and sodium as its concentrated exhibitions. On the other hand, positive electricity is to be regarded as pure oxygen or acidity; and negative electricity as pure hydrogen or alkalinity. It is this elementary character which confers such peculiar powers on electrical contrast and action, and which renders the re-union of the separated principle so subtle and intense in electricity, galvanism, flame, combustion, &c.

Acids are derived either from the gases of the atmosphere, from metals or from animal and vegetable substances. 19 are derived from oxygen, 9 from metals, 9 from hydrogen, 4 from chlorine, and 46 from animal or vegetable substances. In all no less than 87, of which Oxygen is the probable cause.

The most important are

1. Acetic or concentrated vinegar.
2. Arsenic or arsenious, for arsenic.
3. Benzoic, from flowers of Benjamin.
4. Boracic, from borax.
5. Carbonic, as gas, oxygen, and carbon.
6. Citric, from lemons.
7. Fluoric, from spar.
8. Gallic, from nut-galls.
9. Lactic, from milk.
10. Muriatic, from sea salt.
11. Chlorine, oxygenated muriatic acid, considered itself an element.
12. Chloric, from chlorine.
13. Nitric, or aquafortis, from potash.
14. Oleic, from fat.
15. Oxalic, from wood sorrel.
16. Phosphoric, from phosphorus.
17. Prussic, from fruit kernels.
18. Pyrolignous, from wood-smoke.
19. Sorbic, or Malic, from apples.
20. Sulphuric, or Vitriolic, *i. e.* from sulphur.
21. Tartaric, from wine crystals.

Their compounds and varieties constitute the study of chemistry, and are more or less connected with all the compositions of matter, natural and artificial, as in salts, metals, earths, gases, &c. &c.

It is a very mysterious subject to imagine the difference in atoms which renders them acid or alkaline, as well as the condition of neutrality. Their varied powers too in electricity, &c. are equally incomprehensible. We have only this general fact to guide us, that the atoms, when *fixed*, have no such powers; and are only acid, alkaline, &c. when they are fluid or gaseous; *i. e.* when IN MOTION. The Editor of this volume, then, on his own original theory, that all gas, &c. is atoms, in circular motions or orbits, a principle which he regards as an incontrovertible fact, ventures further to suggest, that the varied inclination of the planes of the orbits to surfaces may account for all these varied powers of atoms. Acid atoms may work perpendicularly, alkaline at right angles to them, and neutralization be the intermediate angles; while various circumstances and combinations, as size and velocity, tend to complicate the results.

ACIDS are a class of compound bodies, which have the following characteristic properties: the greater part of them have a sour taste, and most of them are corrosive; they change the vegetable blues to red, are soluble in water, and have great affinity for the alkaline, earthy, and metallic oxides, with which they form neutral salts.

Some acids have no sour taste, but their affinity for the three classes of bodies above-mentioned is always characteristic. If a few drops of sulphuric acid, nitric acid, or muriatic acid, be added to a solution of blue litmus, it becomes red. The same is the case if they be added to other vegetable colours, as violet, &c. Hence these colours are employed as tests of acids, that is, to ascertain when they exist in any substance. We may add the infusion to the fluid in which we are trying to detect an acid, but a more convenient method is, to spread it on paper, and allow it to dry. If a strip of this be put into a fluid in which there is an acid, it instantly becomes red.

Some acids appear only in a fluid state, either gaseous, as carbonic acid, or liquid, as sulphuric acid; others appear in a solid form, or crystallized, as benzoic acid, boracic acid, &c. but display no active acidity, unless their atoms are put in motion, as in fluids or gases.

All acids are compound bodies, and are sometimes divided into four classes, the three first of which are compounded with oxygen; the fourth class consists of those which, at least according to some modern chemists, have no oxygen; *e. g.* sulphuretted hydrogen.

The *first* class consists of acids, compounded with oxygen and one other body; the *second* class comprises the acids compounded of carbon, hydrogen, and oxygen; the *third* class consists of those acids which contain nitrogen, in addition to the three substances above-mentioned.

The ancient chemists were acquainted with but few of the acids now known; they divided them, according to the kingdoms of nature, into mineral, vegetable, and animal acids. This division, however, cannot now be retained, as there are some acids which appear in all the kingdoms; as phosphoric acid.

If the same radical be compounded with different proportions of the acidifying principle, forming different acids, the most powerful acid receives a name from the radical, terminating in *ic*; the weaker, a name formed in the same manner, in *ous*; as *sulphurous acid* and *sulphuric acid*, *nitrous* and *nitric acid*; and, where there are intermediate compounds, the term *hypo* is occasionally added to the compound next above it, in point of acidity. Thus *hyposulphuric acid* signifies an intermediate acid between sulphurous and sulphuric acids; *hypophosphorous acid*, an acid containing less oxygen than the phosphorous acid.

The atomic ratios or equivalent numbers of the several acids are as under. They are all formed by the union of oxygen or the oxygenous principle.

| | |
|---|---|
| Acetic | 50 |
| Crystallized (1 water) | 59 |
| Arsenic | 62 |
| Arsenious | 54 |
| Benzoic | 120 |
| Carbonic | 22 |
| Chloric | 76 |
| Citric | 58 |
| Crystallized (2 water) | 76 |
| Fluoric | 17 |
| Gallic | 63 |
| Hydriodic | 126 |
| Hydrocyanic | 27 |
| Muriatic | 37 |
| Nitric (dry) | 54 |
| Liquid (sp. gr. 1·5) 2 water | 72 |
| Nitrous | 46 |
| Mazic | 70 |
| Oxalic | 36 |
| Crystallized (4 water) | 72 |
| Perchloric | 92 |
| Phosphoric | 28 |
| Phosphorous | 20 |
| Sulphuric (dry) | 40 |
| Liquid (sp. gr. 1·4838) | 49 |
| Sulphurous | 32 |
| Tartaric | 67 |
| Crystallized (1 water) | 76 |

The acids, combined with earths, metallic oxides, or alkalies, form salts; *neutral*, when there is no such excess of acid as affects litmus paper, but *super* or *bi*, when the acid predominates, and *sub*, when the acid itself is deficient in power, as will appear by the test of litmus paper or red cabbage.—*See* ACETIC, NITRIC, &c. and SALTS.

By the theory of Stahl, acids are composed of water united with a base, and as this base, being opposed to water, must be of a dry nature, it was technically called an earth. By the theory of Lavoisier, acids are considered as compounds of oxygen with certain bases; but, lately, the existence of oxygen in all acids has been disputed, and some acids have been conceived to have been produced by the union of hydrogen with certain bases: these acids have been called *hydrogen acids*, or *hydracids*. The bases, which are supposed to be acidified by hydrogen, are sulphur, forming hydro-sulphuric acid; selenium, hydro-selenic acid; tellurium, hydro telluric acid; chlore, hydro-chloric acid, being the muriatic acid of Lavoisier; iodine, hydro-iodic acid. The salts formed by these acids so completely resemble those formed by oxygen acids, that this resemblance has raised objections to the reception of the theory of hydrogen acids; and Berzelius has made experiments which lead him to adopt the theory that salts containing a hydracid do not exist, but that when a hydracid is brought into contact with an oxidated base, the hydrogen of the acid combines with the oxygen of the base and forms water, while at the instant the radicals of both unite mutually in their reduced condition. The product is a substance which resembles so closely the salts of the oxidated radical of the base, that it cannot be distinguished by any of its physical characters.

Dulong has attempted to reconcile this inconsistency by regarding all acids which contain water as hydracids. He joins the oxygen of the water to the acid, and forms, with the radical of the acid and its oxygen, a compound radical, which in union with the hydrogen of the water constitute the hydracid. Thus he regards oil of vitriol, or hydrated sulphuric acid, as a compound of hydrogen with a radical composed of an atom of sulphur and four atoms of oxygen; that is, containing one-third more of oxygen than is usually considered to exist in sulphuric acid.

Acids, *strength of.*—In using acids, to form new combinations, it is necessary to be acquainted with their strength. The hydrometer has been used for this purpose, but in many cases it leads to error, as it can only shew the density of the liquid, and that imperfectly; for, as the density depends only on the relation between the dry acid and the water in which it is dissolved, it is not always proportional to the intensity of the acid quality, as has been shewn in several instances, and therefore a more precise method was necessary.

The London Pharmacopœia proposes the quantity of limestone dissolvable in an ounce measure of the acid, as an index of the strength. At present, the saturation of acids, whose own absolute strength, or that relative to other acids, is to be ascertained with crystallized carbonate of soda, and is preferred, both by the College and chemists.

The various absolute strength of different parcels of the same acid, is determined by observing the quantity of crystallized carbonate of soda, or *sodæ subcarbonas*, that is required to saturate a certain weight of the acid, or of the acid to saturate a portion of the alkali, and this latter is the most usual process.

A few grains of the carbonate are put into a glass, and about twelve times the quantity of warm distilled water, or at least rain-water, is added to dissolve it. A portion of the acid, rather more than sufficient to saturate the alkali, is weighed and dropped into the solution of the carbonate of soda, until the latter ceases to effervesce on the addition of the acid: it is then to be examined by paper tinged with the infusion of Brazil wood, of litmus, or of turmeric, to ascertain whether the mixture still contains any surplus of alkali. The carbonate being thus saturated, the remaining acid is then weighed, and deducted from the original weight, and it will then shew how much has been used in the saturation of the alkali contained in the salt of soda; and its strength, compared with any standard acid of the same kind, will be given.

To compare, however, this strength of acidity with that of other acid liquors, some standard must be fixed upon, and the French use what they call *degrés acidimetriques.* Thus it requires 31 grains of oil of vitriol to saturate 100 grains of carbonate of soda, and this quantity of acid is taken as 100 degrees of the *acidimetric* scale.

The relative strength of other acids is estimated by different methods; the first makes this proportion;—As the weight in grains of any acid used in the preceding experiments, is to the weight of carbonate of soda which it saturates, so are 36 grains, the quantity of oil of vitriol necessary to saturate 100 grains of carbonate of soda, to the number denoting the strength of the acid in degrees of the acidometer.

The *second* is founded upon the axiom that the *acidimetric* strength of any two acids are inversely as the quantities necessary to saturate the same weight of alkali. Then, as only 25 grains of salt of soda were used in the preceding experiment, and these would require 9 grains of oil of vitriol for their saturation, it must be stated, as a proportion, that as the weight of acid (necessary to saturate any given weight of carbonate of soda) is to the weight of oil of vitriol, (necessary to saturate the same,) so are 100, the assigned acidimetric strength of oil of vitriol, to the acidimetric strength of the acid employed.

But, if it should be required, from the quotation of the *acidimetric* strength of any acid, to determine the quantity of salt of soda which any assigned weight of the acid will saturate, then, by reversing the proportion, it will be as 36, the conventional quantity of oil of vitriol, is to the *acidimetric* degree of the acid whose saturating power is required, so is the proposed weight of that acid to the quantity of carbonate of soda which it will saturate.

The *acidimetric* degrees of the several acids, whose power of saturating carbonate of soda is mentioned in the Pharmacopœia, will be as follow:

| | |
|---|---|
| Acidum aceticum fortius, or pyroligneous acid | 30·32 deg. |
| Acidum muriaticum, or spirit of salt | 44·64 |
| Acidum nitricum, or spirit of nitre | 76·32 |

The instrument-makers sell glasses for determining the strength of acids by measure.

ACIDS and ALKALIES, TESTS OF. These consist either of test solutions or test papers. Of *solutions* the only good one is an acid infusion of red cabbage. One or two should be cut into strips, boiling water poured on them, and well stirred, with a little dilute sulphuric acid. It should then simmer for two hours, in a copper or earthen vessel. The fluid being drained off, the process should be repeated on the dregs. The whole is then to be evaporated to half, or third, bottled, and it will keep for a year. A small portion of it, diluted with water, will be converted, by caustic potash, or soda, into an intensely-deep blue. *Test papers* are those of litmus and turmeric. Triturate litmus with hot-water, and mix half a pint with each ounce of litmus; simmer for an hour; decant, and add fresh hot-water twice, evaporating these till they impart a blue colour to paper. The sized paper should then be dipped, and drawn through. The colour should be decided blue, and any acid will turn it red. Keep it from air and light. One ounce of turmeric, to nearly a pint of water, treated in like manner, will dye unsized paper yellow, which alkalies will turn brown. Keep the paper clean and free from light till wanted; or alkalies may be detected by their power of reconverted litmus paper, reddened by an acid, into the original blue.—*Farady.*

Acids and Alkalies are also ascertained and measured by neutralization, and the strength of either determined by the quantity of the other that has disappeared. For this purpose, a tube equal to 100 gr. of water is graduated in 100 parts; and marks made for soda at 23·44 parts, for potash at 48·96 parts, for carbonate of soda at 54·63, and for carbonate of potash at 65. Then an acid, diluted sulphur, at 1·141, should be employed to neutralize 100 grains as above. Acetic acid may be gauged with marble and the proportions weighed; or acids, which combine with lime, may be examined with proportions of lime, referring to the equivalent.

ACIDS FOR VOLTAIC TROUGHS. The best mixture is two ounces of the sulphuric acid and one of the nitric acid of the shops, with 100 of water, well-stirred. Its action on zinc, in producing very small bubbles, proves its fitness. The cells should be filled within half an inch of the tops, and made level by inclining the trough, so that it may run over the edges, from one cell to another. All the zinc plates should, with great care, be in one direction, and the copper in the other.

ACONITA; a vegetable poison, recently extracted from *aconitum napellus*, or wolf's-bane, properly alkaline.

ACORNS, one of the necessaries of life among the ancient Britons, and still eaten roasted. Their fitness for food is proved by their power of fattening hogs, &c. They also yield good lamp-oil.

ACOUSTICS. One of our most important connections with external objects is maintained through the sense of hearing; that is, by an affection which certain actions or motions, in those objects, produce on the mind, by being communicated to it through the ear. The peculiar excitation or motion perceptible by the ear, is called *sound*; and the consideration of this motion, its qualities and transmission, forms the science of acoustics. Philosophers make a distinction between sound and noise; thus those actions which are confined to a single shock upon the ear, or a set of actions circumscribed within such limits as not to produce harmonious sensation, are called a *noise*; while a succession of actions which produce a continued sensation, are called a *sound*. Each of these agitations influences the adjacent parts, which, in turn, influence those beyond them, until the whole mass assumes a tremulous motion; that is, certain parts approach to and recede from each other; and it only recovers its former state of repose, after having performed a number of these mechanical vibrations. When fluids, whose elasticity is confined to re-action, emit sounds, a force equivalent to that of re-action in solids is supplied to them by external pressure. The sonorous vibrations of bodies are exceedingly curious, and the more difficult to be understood from our habits of measuring changes or motions by the sight; but these motions affect very sensibly another organ, while they are almost imperceptible to the eye; and, as we are without the means of converting the ideas derived from one sense into those derived from another, the sensation of the motion of sound does not assist us to understand its precise nature, as compared with visible motions. Thus, the ear at once perceives the difference between a grave and an acute sound; but it is only from attentive observation by the eye, that we discover the different rapidity of succession in the vibrations which produce them. The vibrations of a great many bodies, as strings, bells, and membranes, when emitting sounds, may, however, be distinctly seen, and even felt; but they may often be rendered more sensible to the eye by a little artifice, such as sprinkling the vibrating body with sand, or some light mobile substance.

The most obvious characteristics, by which we distinguish different sounds, consist of differences in their degrees of what we call loudness, and acuteness, or *pitch*. We can produce, at pleasure, sounds having different degrees of loudness, from the same sonorous body, by making the concussions upon it more or less violent, *i.e.* disturbing in a greater or less degree the arrangement of its parts.

The other principal characteristic of sound, its acuteness or pitch, depends upon the frequency with which the concussions or vibrations of the sonorous body succeed each other. That sounds may be audible to a common ear, it is necessary that the concussions upon the medium, which communicates them, should follow each other in such succession, that not more than 8192, nor less than 32, distinct concussions shall be made upon the medium during the lapse of one second. Some ears, however, can perceive sounds emanating from vibrations a little beyond the extremes to which the perceptions of other ears are confined. We should be careful not to confound the frequency of vibrations with the velocity of vibratory motion. A string may vibrate with a greater or less velocity, as it passes its axis to a greater or less distance; yet the times of its vibrations may be all equal. The difference of velocity, affecting the quantity of motion only, would produce no change, except in the loudness of the sound.

To those sounds which proceed from infrequent vibrations, we give the name of *grave* or *low*; those from more frequent vibrations we call *sharp* or *acute*.

When vibrations succeed each other in equal times, their sound excites a pleasant sensation, and they are called *musical*. When two bodies are made to sound together, if their vibrations are performed in equal times, the sounds are said to be in *unison*. When the vibrations are performed in unequal times, so that some of those of the one are not accompanied by those of the other, the ear perceives a degree of dissonance in the sounds. If, however, the vibrations meet after short and regular intervals, the dissonance is not easily detected, and the sounds are said to *accord*.

The air, being the common medium which surrounds the ear, is that by which sounds are usually transmitted. This transmission is performed with a velocity of about 1130 feet in a second. All other bodies, however, are capable of transmitting sound. It may be done perfectly, even by the solid parts of the head. If, for example, we hold the stem of a watch between the teeth, and cover the ears with the hands, the beats are heard more distinctly than when the instrument is held at an equal distance in the air. The rubbing together of two stones under water may be heard, by an ear in the same medium, at the distance of half a mile.

When the air, or any other body of indefinite extent, is disturbed, in a point situated within it, by a sonorous vibration, it forms a wave, which passes from the disturbed point, as a centre, in every direction. It follows that as the wave extends itself, the mass to be put in motion increases until the original motion is rendered insensible from the magnitude of the mass to which it has communicated itself. The velocity with which waves, thus formed, move through any homogeneous elastic medium, is always equal to that which a heavy body would acquire by falling through half the height of the modulus of elasticity, $\frac{27,800}{2}$. In applying this law to the transmission of sound by the air, it was for a long time found not to give the same results as were obtained by experiment. The discrepancy, however, has been most ingeniously reconciled by a small correction for the created heat by the compression; the effect of this being to increase the height of the modulus of elasticity. Therefore, liquids, and more especially some of the solids, transmit sound much more rapidly than air. Cast-iron, for example, has been found to transmit sound with a velocity $10\frac{1}{2}$ times greater than air.

Sound does not readily pass from one medium to another: a sound made in the air, is not easily distinguished under water, although the distance be very small. It is from this, probably, that cork and all soft cellular bodies are bad conductors of sound, as in these the sound must, in passing through the walls of the cells and the air contained in them, change successively from one medium to another.

All sounds, whatever be their loudness or pitch, are transmitted with the same velocity; a fact most completely proved by every musical performance. Were it otherwise, indeed, this beautiful art could not exist. To make this apparent, it is only necessary to consider, that harmony is a combination of different sounds arranged with certain relations of time and pitch. Now, if one sound were transmitted with greater velocity than another, these relations would differ at different distances, or be confounded, except at a single given point. And, further: melody, which is a succession of single sounds, would not reach different ears with the same relations of time, if the different notes were not transmitted with equal velocities. When a wave of sound meets an elastic surface, it is partly transmitted and partly reflected. This reflection, when it returns back perpendicularly, is called an *echo*. That an echo may be distinctly heard, it is necessary that the reflecting surface be at such a distance that the original sound shall have ceased before the reflected one returns to the ear; otherwise they will be blended, and the echo not perceived.

When diffusion is prevented by enclosing the medium in a surface capable of reflecting the wave, so that the sound shall be confined to one direction, the transmission from one point to another is much more perfect. Experiments have been made in this way, in which a hollow cylinder, about half a mile long, was formed by cast-iron pipes. The sound was transmitted by the air, in this cylinder, with wonderful distinctness. The least whisper, at one end of the cylinder, was distinctly heard at the other end. So perfect, indeed, was the transmission, "that, not to hear, it was absolutely necessary not to speak." Captain Parry and lieutenant Foster made several experiments, during the northern expeditions, to ascertain the velocity of sound. The mean results varied from 12″·7617 to 11″·7387 and 11″.5311 for the seconds in which the range of 12892·89 feet was traversed by the sound. At the period of the experiment which gave the first of these results, there was a calm; during the second, the wind was light; during the third, a strong wind was blowing. The velocity per second, in feet, was, in the first instance, 1010·28; in the second, 1098·32; in the third, 1118·1. The mean of a table of velocities, formed from observations made at Fort Franklin, gives a velocity of 1069·28 feet per second, at the temperature of 9·14, Fahrenheit.

ACRE, is 4840 square yards, its quantity for many ages having undergone no change by the late act, as some authors insinuate; 640 acres make a square mile. It is divided into 4 square roods, each 1210 square yards; each rood 40 square perches of $30\frac{1}{4}$ square yards. The acre is 69·57 yards on each side, or 69 yards 1 foot $7\frac{1}{3}$ inches. The rood 34·785 yards each way, or 34 yards 2 feet 4 inches, and the pole 5·5 yards or 5 yards 1 foot 6 inches. The chain is used in land-measuring, and it is so apportioned, that 10 square chains are an acre, *i. e.* 3·16228 chains, or $316\frac{1}{4}$ links, or 69·57 yards each way. The chain is 100 links of 7·92 inches, so that it is 66 feet, or 22 yards long, which is 4 poles; hence, a chain, or 100 links in length and breadth, is 16 square poles, or one tenth of an acre; 25 links each way are one square pole, and 10 chains each way are 100 square chains, or 1600 square poles, equal to 10 acres.

The Scotch acre is to the English as 5 to 4 nearly, and the Irish as 13 to 8 nearly. The English acre is generally used in America.

ADDITION OF FRACTIONS, is best effected by converting them into decimals. Thus $\frac{2}{3}$ and $\frac{3}{5}$ are 0·666 and 0·6, whose sum is 1·2666. If added by a common denominator, it is $\frac{10}{15}$ and $\frac{9}{15} = \frac{19}{15} = 1\frac{4}{15}$. And the $\frac{4}{15}$ in a decimal is ·2666. *See* DECIMALS.

ADHESION, according to the latest phraseology of physics, means generally the tendency of heterogeneous bodies to stick together; but *cohesion* implies the fitting of homogeneous particles of bodies. Adhesion may take place between two solids, as two hemispheres of glass, or between a solid and a fluid, or between two fluids, as oil and water. Thus it is said that a fluid adheres to a solid, as water to the finger dipped into it. But there is a great difference in this respect, in different bodies; thus small particles of quicksilver do not adhere to glass, but they adhere to gold, silver, and lead. Water adheres to the greatest part of bodies, unless it is separated from their surface by oily substances, dust, flour, &c. Fluids do not form a surface perfectly horizontal in vessels to which they adhere, so as to wet them, but rise, on the contrary, around the brim of the vessels. This is proved by water, beer, &c. poured into glasses, pails, pots, &c. Fluids, on the other hand, in vessels to which they do not adhere, sink around the brim, and rise in the centre. Thus quicksilver in a glass forms a convex surface. This phenomenon of the rising and sinking of fluids becomes still more remarkable in vessels of a small diameter; wherefore capillary tubes, so called, are used for performing experiments.

ADHESIVE PLASTER, consists of 6

lbs. of diachylon, and 1 lb. of liquid resin; or, olive oil 8 lbs. litharge $4\frac{1}{2}$ lbs. and $1\frac{1}{2}$ lbs. of liquid resin, spread on calico. It is much used in surgery, to keep the lips of wounds together, and also to secure dressings.

ADIPOCIRE, from *adeps*, fat, and *cera*, wax, a substance of a light-brown colour, formed by the soft parts of animal bodies, when kept for some time in water, or when preserved from atmospheric air. When this substance is subjected to a chemical analysis, a true ammoniacal soap is first yielded, composed of ammonia, a concrete oil and water. The oil may be obtained pure, and this is strictly called Adipocire. It was discovered on removing the animal matter from the burial-ground of the church *des Innocens*, at Paris, in 1787, amongst the masses of the bodies of the poor there interred together. In this place, about 1500 bodies were thrown together into the same pit, and, being decomposed, were converted into this substance.

ADRAGANTH, or Gum Dragon, is a gum of various colours, which exudes from a Levant plant.

ADY, is a Palm of the island of St. Thomas, of the juice of which wine is made, and the fruit is eaten roasted, or converted into good oil.

ÆOLIPILE, a globe filled with hot fluid, with an orifice or small pipe for the steam to escape with noise.

ÆOLIAN HARP, strings arranged on a board, and placed in a draft of air, which vibrates them in pleasing tones. Some are placed on a sounding-board; others between two boards.

AERATED SODA POWDERS, are half a drachm of carbonate of soda, in one paper, and 25 grains of acid of tartar in another paper, to be mixed in half a pint of water.

AERIAL PERSPECTIVE, is the effect of distance on the colours of bodies, as necessary in painting as the effect of distance on bulks or angles. Colours diminish in lustre as well as bodies in size by distance.

AERIFORM SUBSTANCES, are properly the gases and vapours treated of under those heads, but a solid does not become fluid and gaseous, without some mechanical energy, or change in the relation of its parts. This change may be understood, because we know the chief cause—heat or motion. This, imparted to a solid or liquid, causes its atoms to radiate into the adjoining space with intensity, varied as the heat or motion applied, and the space being previously full of atoms, the conflict and continued deflections produce a volume of gas, or what is called an æriform state of the solid or liquid. Rectilinear motion, radiation, or projection with obstruction and deflection, would produce a spherical volume, and turn the atoms into orbits, and this accords with all the phenomena of elasticity, varied expansion, &c.—*See* GAS, LIQUID, EXPANSION, COMPRESSION, &c.

AFFINITY, the attraction of cohesion and elective attraction, are favourite terms of chemists, but ought to be regarded as mere conventional terms and signs of ignorance. No matter has, or can have any active property *per se*, and the laws of definite proportions prove, that all affinities are strictly mechanical and geometrical. The smaller the atoms the better they fit, and when fitted, no tool is fine enough to separate them; and we resort, for their separation, to percussion or to the motion of heat, thereby rendering them fluid or gaseous, and in mechanical motion, when they combine or recombine in geometrical or in arithmetical proportions, relatively at once to their forms and to their motions. This is affinity, &c. universally.

AGALMATOLITE, is a mineral substance used in China, to make figures and ornaments. It is plastic, and may be cut with a knife. Its colours are various, and it has been considered the best material for the Wedgwood pyrometer.

AGARIC TINDER, is the soft inner substance of the bark of a tree, oak being preferred. It is boiled in lye, dried and boiled again in a solution of nitrate of potash, and is then a tinder more susceptible than burnt rags.

AGATES, are compounds of chalcedony, jasper, quartz, &c. so variegated as often to represent objects. It is manufactured into various trinkets, and to be found in most countries.

AGAVE AMERICANA. The sap of the leaves is so saccharine, as to be used as honey, and to make a wine called *pulque*. In the *Agave vivipera*, the juice of the leaf is mixed with lime-juice and treacle, and makes a good dressing for ulcers. The inspissated juice is a plaster in gout; roots chewed in diarrhœa.

AGRICULTURE, is the art of cultivating the earth in such a manner as to cause it to produce, in the greatest plenty and perfection, those vegetables which are useful to man, and to the animals which he has subjected to his dominion. This art is *the basis of all other arts*, and in all countries coeval with the first dawn of civilization. Without agriculture, mankind would be savages, thinly scattered through interminable forests, with no other habitations than caverns, hollow trees, or huts, more rude and inconvenient than the most ordinary hovel or cattle-shed of the modern cultivator. It is the most universal as well as the most ancient of the arts, and requires the greatest number of operators. It employs seven-eighths of the population of almost every community. The first mention of agriculture is in the writings of Moses. From them we learn that Cain was a "tiller of the ground," that Abel sacrificed the "firstlings of his flock," and that "Noah began to be a husbandman, and planted a vineyard." The Chinese, Japanese, Chaldeans, Egyptians, and Phœnicians appear to have held husbandry in high estimation. The Egyptians were so sensible of its blessings, that they ascribed its invention to superhuman agency, and even carried their gratitude to such an absurd excess as to worship the ox, for his services as a labourer. The Carthaginians carried the art of agriculture to a higher degree than other nations, their contemporaries.

Hesiod, a Greek writer, contemporary with Homer, wrote a poem on agriculture, entitled *Weeks and Days*, which was so denominated because husbandry requires an exact observance of times and seasons. Other Greek writers wrote on rural economy, and Xenophon among the number, but their works have been lost in the lapse of ages. The implements of Grecian agriculture were very few and simple. Hesiod mentions a plough, consisting of three parts—the share-beam, the draught-pole, and the plough-tail; but antiquarians are not agreed as to its exact form; also a cart with low wheels, and ten spans (seven feet six inches) in width; likewise the rake, sickle, and ox-goad; but no description is given of the mode in which they were constructed. The operations of Grecian culture, according to Hesiod, were neither numerous nor complicated. The ground received three ploughings—one in autumn, another in spring, and a third immediately before sowing the seed. Manures were applied, and Pliny ascribes their invention to the Grecian king Augeas. Theophrastus mentions six different species of manures, and adds, that a mixture of soils produces the same effect as manures. Clay, he observes, should be mixed with sand, and sand with clay. Seed was sown by hand and covered with a rake. Grain was reaped with a sickle, bound in sheaves, threshed, then winnowed by wind, laid in chests, bins, or granaries, and taken out as wanted by the family, to be pounded in mortars or quern-mills into meal.

The Romans venerated the plough, and, in the earliest and purest times of the republic, the greatest praise which could be given to an illustrious character was to say that he was an industrious and judicious husbandman. M. Cato, the censor, who was celebrated as a statesman, orator, and general, having conquered nations and governed provinces, derived his highest and most durable honours from having written a voluminous work on agriculture. In the Georgics of Virgil, the majesty of verse and the harmony of numbers add dignity and grace to the most useful of all topics. The celebrated Columella flourished in the reign of the emperor Claudius, and wrote twelve books on husbandry, which constituted a complete treatise on rural affairs. Varro, Pliny, and Palladius, were likewise among the distinguished Romans who wrote on agricultural subjects.

But the husbandmen of antiquity, as well as those of the middle ages, were destitute of many advantages enjoyed by the modern cultivator. Neither the practical nor the theoretical agriculturalists of those periods had any correct knowledge of geology, mineralogy, chemistry, botany, vegetable physiology, or natural philosophy; but these sciences have given the modern husbandman the command of important agents, elements, and principles, of which the ancients had no idea. The precepts of their writers were conformable to their experience; but the *rationale* of the practices they prescribed they could not, and rarely attempted to explain. Nature's most simple modes of operation were to them inexplicable, and their ignorance of causes often led to erroneous calculations with regard to effects. We are indebted to modern science for the following, among other improvements: viz. 1. A correct knowledge of the nature and properties of manures, mineral, animal, and vegetable; the best modes of applying them, and the particular crops for which particular sorts of manures are best suited. 2. The method of using all manures of animal and vegetable origin while fresh, before the sun, air, and rain, or other moisture, has robbed them of their most valuable properties. It was formerly the practice to place barn-yard manure in layers or masses for the purpose of rotting, and turn it over frequently with the plough or spade, till the whole had become a mere *caput mortuum*, destitute of almost all its original fertilizing substances, and deteriorated in quality almost as much as it was reduced in quantity. 3. The knowledge and means of chemically analyzing soils, by which we can ascertain their constituent parts, and thus learn what substances are wanted to increase their fertility. 4. The introduction of the root husbandry, or the raising of potatoes, turnips, mangel-wurzel, &c. extensively, by field husbandry, for feeding cattle, by which a given quantity of land may be made to produce much more nutritive matter than if it were occupied by grain or grass crops, and the health, as well as the thriving, of the animals in the winter season greatly promoted. 5. Laying down lands to grass, either for pasture or mowing, with a greater variety of grasses, and with kinds adapted to a greater variety of soils; such as orchard-grass, *dactylis glomerata*, for dry land; foul-meadow-grass, *agrostis stricta*, for very wet land; herds grass, or timothy, *phleum pratense*, for stiff clayey soils, &c. &c. 6. The substitution of fallow crops (or such crops as require cultivation and stirring of the ground while the plants are growing,) in the place of naked fallows, in which the land is allowed to remain, without yielding any profitable product, in order to renew its fertility. 7. The art of breeding the best animals and the best vegetables, by a judicious selection of individuals to propagate from.

Considerable improvement in culture was introduced by Jethro Tull, who began to drill wheat and other crops, about the year 1701, and whose Horse-hoeing Husbandry was published in 1731. After the time of Tull's publication, no great alteration in British agriculture took place, till Robert Bakewell of Dishley, in 1783, effected some important improvements in the breed of cattle, sheep, and swine. By skilful selection at first, and constant care afterwards to breed from the best animals, Bakewell at last obtained a variety of sheep, which, for early maturity, and the property of returning a great quantity of mutton for the food which they consume, as well as for the small proportion which the weight of the offal bears to the four quarters, were without precedent.

A suitable *succession of crops* is a very important branch of husbandry. Farinaceous, or grain crops, ripening their seeds, should never be repeated, without the intervention of pulse, roots, or herbage. This order of succession is called the system of *rotative husbandry*. It is the most productive of all others, both in crops for man, and for animals; nor should we repeat the same kind of crop at too short intervals. The degeneracy of wheat, and other corn crops, upon the same land every second or third year, is well known; and it is the same with beans and peas, potatoes, turnips, and red clover; all of which are less productive, and more liable to disease, when they are grown on the same land too often. A change also of the *variety* of seed, as well as in *species*, is advantageous. Ignorance of this law of production has often unpeopled countries.

*Agricultural Implements*, in former times, consisted only of the spade, the pick-axe, or mattock, the hoe, the plough, the harrow, the roller, the two-prong and four-prong fork, the scythe, the sickle, and the rake. All these are probably as old as culture itself; but improvements in mechanics, the facility of working iron, and a greedy disposition to dispense with manual labour have, for some years, combined the business of an enlightened farmer with that of a machinist.

Of *Ploughs*, there are a great variety, adapted to different purposes and soils. The swing-plough is most generally used; the Rotherham plough, with a mould-board, is a favorite in England; wheel-ploughs, of various forms, are adopted in Kent, Norfolk, &c. and bear the name of the counties. Two, three, and four-furrow ploughs have been contrived, as experimental articles. There is, also, the paring-plough, the mole-plough, &c. The force of resistance in the working of different ploughs varies from three to five cwt.

The next class are *Grubbers*, *Harrows*, and *Breakes*, with less variety of form; and also *Rollers*.

*Drill Machines*, for sowing in rows, are of comparatively modern invention, but are generally used in some districts, and in as many forms as machinists. These are accompanied with *Horse-hoes*, and Morton's drill-plough and harrow are recommended.

There also are horse-rakes, to save labour; a horse raking twenty or thirty acres per day, and so clean as, in Scotland, to leave nothing for gleaners.

*Reaping Machines* have been attempted in some districts, but as no compensation is offered to agricultural labourers, who are jealous of their use, and they are complicated and expensive, they have been used with little success. Boyce's, Salmon's, and Smith's are the most approved.

The *Hainault Scythe*, which collects and lays its produce even for tyeing, has recently been introduced in Scotland, a country where there appears to be a great scarcity of agricultural labourers, owing partly to the preferences given to machines, and to emigrations to England, and other countries.

*Threshing Machines* are in general use on large farms, or such as employ above two ploughs. They are worked by horses, or water, and, in some situations, by wind or steam. They were a Scotch invention, and more used in Scotland than in England. Meikle's is approved. A horse-mill costs 70*l.*; a water-mill 80*l.* or 90*l.*; and a wind-mill

2 or 300*l*. There are also hand thrashing-machines, worked by one or two men, made for 8*l*. or 10*l*., which thresh ten or twelve bushels an hour.

*Winnowing Machines* have been in ancient use. Four or five persons may winnow and measure into sacks twenty quarters per day, by this machine.

*Chaff-cutters*, *Turnip Slicers*, *Corn Bruisers*, *Steamers*, &c. are also necessary in most farms.

*Carts*, adapted for one or two horses, are preferred to waggons in most farm business.

*French agriculture* began to flourish early in the 17th century.

The lands in France are not generally enclosed and subdivided by hedges or other fences. Some fences occur near towns, but, in general, the whole country is open, the boundaries of estates being marked by ditches or ridges, with occasional stones, or heaps of earth, and trees in rows. Depredations from passengers on the highways, are prevented by *gardes champetres*, which are established throughout all France. Since the time of Colbert, the French have paid attention to sheep, and there are considerable flocks of Merinos owned by individuals, besides the national flocks. That of Rambouillet, established in 1786, was managed by Tessier, an eminent writer. Sheep are generally housed, or kept in folds and little yards or enclosures. Where flocks remain out all night, the shepherd sleeps in a small thatched hut, or portable house, placed on wheels. He guides the flock, by walking before them, and his dog guards them from wolves, which still abound in some parts. In the south part of France, the ass and the mule are of frequent use in husbandry. Poultry is an important article in French husbandry. Birkbeck thinks that the consumption of poultry in towns is equal to that of mutton. The breed of swine is bad; but hams are made in Bretagne, from hogs reared on acorns, and fatted with Indian corn.

French implements of agriculture are generally rude and unwieldly, and the operations of husbandry unskillfully performed. The vine is cultivated in France, in fields, and on terraced hills, in a way different from that which prevails elsewhere. It is planted in hills, kept low, and managed like a plantation of raspberries.

The white mulberry-tree is very extensively cultivated for feeding the silk-worm. It is not placed in regular plantations, but in corners, in rows by the sides of roads, &c. The trees are raised from the seed in nurseries, and sold, generally, at five years' growth, when they have strong stems. They are planted, staked, and treated as pollards. The eggs of the silk-worm are hatched in rooms heated by means of stoves to 72½ Fah. One ounce of eggs requires one hundred weight of leaves, and will produce from seven to nine pounds of raw silk. The hatching commences about the end of April, and, with the feeding, is over in about a month. Second broods are procured in some places. The silk is wound off the cocoons, in little balls, by women and children.

The olive, the fig, the almond, and various other fruits are also extensively cultivated in France.

*German Agriculture.* The produce is for the most part consumed within its limits; but excellent wines are exported from Hungary and the Rhine, together with flax, hams, geese, silk, &c. The culture of the mulberry, and the rearing of the silk-worm, are carried on as far north as Berlin.

Generally speaking, the ploughs, waggons, &c. are unwieldy, and inefficient.

The culture of forests likewise receives particular attention in that country, as well as in France. Governments as well as individuals have formed institutions. The Imperial Society of Vienna, the Georgical Institution at Presburg, and that of Thaer, in Prussia, are among recent institutions of this description. Corn, grass, meat, cheese, butter, rice, silk, cotton, wine, oil, and fruits of all kinds, are found in perfection in this fertile country.

Irrigation of lands in Lombardy is a remarkable feature of Italian husbandry. All canals taken from rivers are the property of the state, and may be carried through any man's land, provided they do not pass through a garden, or within a certain distance of a mansion, on paying the value of the ground occupied. Water is not only employed for grass-lands, (which, when fully watered are mowed four, and sometimes five times a year, and, in some cases, as early as March,) but is conducted between the narrow ridges of corn-lands, in the hollows between drilled crops, among vines, or to flood lands, to the depth of a foot or more, which are sown with rice. Water is also used for depositing a surface of mud, in some places where it is charged with that material. The details of watering, for these and other purposes, are given in various works. In general, watered lands let at one-third higher price than those not irrigated. The implements and operations are imperfect. The plough is a rude contrivance, with a handle 13 or 14 feet long. But the cattle are fed with extraordinary care. They are tied up, bled once or twice a year, cleaned and rubbed with oil, afterwards combed and brushed twice a day. Their food in summer is clover, or other green herbage; in winter, a mixture of elm-leaves, clover-hay, and pulverized walnut-cake, over which boiling water is poured, and bran and salt added. In a short time, the cattle cast their hair, grow smooth, round, and fat. The tomato or love-apple, so extensively used in Italian cookery, forms an article of field-culture near Pompeii, and especially in Sicily, from whence it is sent to Naples, Rome, &c.

*American Agriculture.* The agriculture of that wide-spread country embraces all the products of European cultivation, together with some (as cotton, rice, sugar, and indigo) which are rarely made objects of tillage in Europe. The farms of the Eastern, Northern, and Middle States consist, generally, of from 50 to 200 acres, seldom rising to 300, and generally falling short of 200. These farms are enclosed, and divided either by stone-walls, or rail fences made of timber, hedges not being common.

The buildings first eracted on a "new lot," or on a tract of land not yet cleared from its native growth of timber, are what is called a *log house* This is a hut or cabin made of round straight logs, about a foot in diameter, lying on each other, and notched in at the corners. The intervals between the logs are filled with slips of wood, and the crevices generally stopped with mortar made of clay. The fire-place commonly consists of rough stones, so placed as to form a hearth, on which wood may be burned. Sometimes these stones are made to assume the form of a chimney, and are carried up through the roof; and sometimes a hole in the roof is the only substitute for a chimney. The roof is made of rafters, forming an acute angle at the summit of the erection, and is covered with shingles, commonly split from pine-trees, or with bark, peeled from the hemlock *(pinus canadensis.)*

When the occupant, or "first settler" of this "new land," finds himself in "comfortable circumstances," he builds what is styled a "frame house," composed of timber, held together by tenons, mortises, and pins; boarded, shingled, and weather-boarded on the outside, and often painted white, sometimes red. Houses of this kind generally contain a dining-room and kitchen, and three or four bed-rooms on the same floor. They are rarely destitute of good cellars, which the nature of the climate renders almost indispensable. The farm-buildings consist of a barn, proportioned to the size of the farm, with stalls for horses and cows on each side, and a threshing-floor in the middle; and the more wealthy farmers add a cellar under the barn, a part of which receives the manure from the stalls, and another part serves as a store-room for roots, &c. for feeding stock. What is called a *corn-barn*, is likewise very common, which is built exclusively for storing the ears of Indian corn. The sleepers of this building are generally set up four or five feet from the ground, on smooth stone posts or pillars, which rats, mice, or other interlopers cannot ascend.

With regard to the best manner of clearing forest-land from its natural growth of timber, the following observations may be of use to a "first settler." In those parts of the country, where wood is of but little value, the trees are felled in one of the summer months, the earlier in the season the better, as the stumps will be less apt to sprout, and the trees will have a longer time to dry. The trees lie till the following spring, when such limbs as are not very near the ground should be cut off, that they may burn the better. Fire must be put to them in the driest part of the month of May, or, if the whole of that month prove wet, it may be applied in the beginning of June. Only the bodies of the trees will remain after burning, and some of them will be burned into pieces. Those which require to be made shorter are cut in pieces nearly of a length, drawn together by oxen, piled in close heaps, and burned, such trees and logs being reserved as may be needed for fencing the *lot.* The heating of the soil so destroys the green roots, and the ashes made by the burning are so beneficial as manure to the land, that it will produce a good crop of wheat or Indian corn without ploughing, hoeing, or manuring.—If new land lie in such a situation, that its natural growth may turn to better account, whether for timber or fire-wood, it will be an unpardonable waste to burn the wood on the ground. But if the trees be taken off, the land must be ploughed after clearing, or it will not produce a crop of any kind.—*Encyclopædia Americana.*

The climate and soil of the United States are adapted to the cultivation of Indian corn, a very valuable vegetable. This entirely, and very advantageously supersedes the field culture of the horse-bean *(vicia faba).* The winters are so severe in the northern section of the Union, that turnips can rarely be fed on the ground, and all sorts of roots are with more difficulty preserved and dealt out to stock, in this country, than in those which possess a milder climate. Hay is easily made from grass in the United States, owing to the season for hay-making being generally more dry, and the sun more powerful. The American farmer is generally the owner, as well as the occupier of the soil which he cultivates; is not burthened with tithes; his taxes are light; and the product of his labours will command more of the necessaries, comforts, and luxuries of life.

Assignable property in the soil, in return for the cost of first cultivation, is recognized in all countries; but this title becomes oppression, when the rental is a third of the produce, and often slavery, even at a fourth. The best proportion for landlord and tenant, on a term of years, is a fifth clear to the landlord, the tenant expending an eighth or tenth in improvements.

In England, the farming, as well as every productive interest, has been in stagnation and deterioration since a parliament and administration, in 1826-7, not only neglected to sustain that Credit which constituted, in its aggregate, the real *capital* of the nation; but ignorantly deprived the people of the current means of sustaining credit and meeting their obligations. In consequence, improvements have been arrested, fewer labourers employed, and anxiety, distress, and misery, have been spread through districts fraught with the means of plenty and happiness. Neither a corn-bill, nor any reduction of rents, rates, and taxes, can atone for the withdrawal of that capital of credit, which, in England, till 1826, was worth, on a moderate estimate, at least 2000 millions sterling.

AGUE, in medicine; a disorder belonging to the class of intermittent fevers. It may be followed by serious consequences, but, generally, it is more troublesome than dangerous, and is sometimes even salutary. According to the length of the fit, or intermission between one febrile paroxysm and another, agues are denominated *quotidians*, *tertians*, or *quartans*; which latter are much the most obstinate, being generally attended with a greater degree of visceral obstruction.

An ague paroxism has been divided into the cold, the hot, and the sweating stages. The feeling of extreme cold, in the first stage, cannot be prevented by fire, or the heat of summer. Generally, after the sweating stage, in which there is a profuse exhalation from the pores of the skin, with a flow of urine, depositing a copious sediment, of a milky or brick-dust appearance, the patient falls into a refreshing sleep, from which he awakes without any remains of indisposition, except a slight degree of languor and debility.

Agues occur chiefly in situations where there are shallow, stagnant waters. Hence their frequency in Holland, Essex, in the East and West Indies, in the flat, marshy parts of England, and the thinly-settled parts of the United States, where they diminish with the clearing of the woods, and the draining of the lands. The neighbourhood of rivers or marshes, therefore, is carefully to be avoided by persons afflicted with agues. They are cured by medicines, which, at the same time that they exert a tonic influence, produce and keep up an impression upon the system greater than that communicated by the causes of the disease; such as Peruvian bark, quinine, various bitter and astringent drugs, certain metallic salts, &c. but never by charms, superstition, and quackery.

AIR, in natural philosophy, is that fluid transparent substance which surrounds our globe, reaching to a considerable height above its surface, and this ocean of air is the great laboratory in which most of the actions of life go on, and on the composition of which they depend. *(See* Gas.*)* Though invisible, except in large masses, without smell or taste, yet it is a substance, possessing all the principal attributes of matter. It is impenetrable, ponderable, compressible, dilatable, perfectly elastic, and its particles are operated on like those of other bodies, by chemical action. To prove the impenetrability of the air, a very simple experiment is sufficient. Plunge a glass receiver perpendicularly into water, after having put under the receiver a piece of cork. However deep you may plunge the vessel, the water never reaches the top of it, though it diminishes the volume of the air; the liquid, therefore, cannot penetrate the air. The cork serves to shew how high the water rises. In fact, the most common occurrences give constant proofs of the impenetrability of the air, and the theory of sailing, of windmills, &c. is based on that property.

To prove that the air is ponderable, it is only necessary to weigh a large balloon, first empty, and afterwards filled with air. It has been found, that 100 cubic inches of air, very dry, taken at the temperature of 60°, and under the barometrical pressure of 30 inches, weighs 30·5 grains; and this weight is to that of water as 1 to 770.

Then, as there are 7000 grains in a lb. avoirdupois, in which 30·5 (the weight of 100 cubic inches) goes 229 times, so it takes 22900 cubic inches to a lb. Then, as there are 1728 cubic inches in a cubic foot, this goes above 13 times in 22900, and it requires, therefore, above 13 cubic feet of air to make a lb. In this way the enquiry may be pushed in various ways. Thus, a room, 20 feet long, 15 wide, and 10 high, contains 3000 cubic feet; which, divided by 13, gives 230 lbs. of air in such a room.

In consequence of this quality of air, the atmosphere which surrounds us exerts a pressure on all points of the globe proportionate to its weight; this is the cause of the rise of liquids in pumps, siphons, pores, and the barometer. To show this pressure, plunge the orifice of an exhausted tube, closed at the other end, into a liquid. The liquid, yielding to the pressure of the external air, rises in the tube till the weight of its column is equal to that of the atmospheric column. In this experiment water will rise 34 feet, and mercury 29 inches, provided the place where the experiment is tried, is nearly on a level with the sea; for the height varies with the weight of the column of air, which diminishes in proportion as we ascend above the level of the sea. The height of the column of mercury in the barometer, therefore, affords a good means of determining the elevation of any given place. The weight of the column of air, which presses constantly on a man of middle stature, is equal to 32,343¼·25 lbs. But this weight does no injury, because it is counterbalanced by the reaction of the fluids and air, which fill the interior cavities of the body.

That air is compressible, and that the space which it occupies corresponds always to the pressure on it, has been shewn by Mariotte. He took a bent glass tube, with legs of unequal length, exactly graduated; after having sealed the orifice of the shorter leg, he introduced a small quantity of mercury, sufficient to rise to an equal height in both legs. The air enclosed in the shorter leg then counterbalanced the atmospheric column. By raising the mercury in the longer leg to the height of 29 inches, the air in the shorter leg was compressed into half the space which it occupied at first. In other words, the weight of two atmospheres (the column of mercury being equal to one) compressed the air to this degree. Mariotte continued to pour mercury into the long leg, and found that the weight of 2, 3, 4, &c. atmospheres reduced the air confined in the shorter leg to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. of its primitive volume. The compression of air would be indefinite, if we had sufficiently powerful means; but as yet we have only been able to reduce its volume to one eighth.

The dilatability of air consists in the tendency of a volume of confined air to occupy a greater space. In consequence, it presses equally in all directions on the sides of the vessel containing it, and this pressure increases or diminishes in proportion as the enclosed air is condensed or rarefied, provided the temperature remains the same. The dilatability of air has, according to the preceding experiment, no limits. A bladder, almost empty, will become inflated if placed in an exhausted receiver. Elasticity being the power of a body to resume its original form as soon as the force which changes it ceases, it is evident, from what we have said, that it is a power of air, and this power arises from the orbits of the atoms, which enlarge or contract by excitement.

Of the Chemical properties of air, it will be sufficient to mention the following: the ancients believed it a simple body, one of the four elements. But modern chemists discover that it is composed of two bodies, apparently elementary, — oxygen and nitrogen. The most accurate experiments have shown that this fluid, taken from different parts of the globe, and even at a great height, is composed of 20 parts of oxygen, 80 of azote. 1 part of carbonic acid and some atoms of hydrogen encroach on these proportions.

The air refracts the rays of light, and its power of refraction is in the ratio of its density. It is capable of acquiring electricity, and is an electric, and as such the immediate cause of our electrical phenomena.

When subjected to great heat or cold, it is dilated or condensed, but undergoes no change of properties. If it is suddenly compressed, much heat is disengaged, with a bright light. It enters bodies through the most minute pores, and adheres to them strongly; coal, particularly, absorbs a great quantity of air. Water and all liquids always contain it, and it can only be expelled by a strong heat.

The heat and light developed by compression prove, that it consists of atoms in motion; since, when the space is less the motion is less, and the motion parted with, produces the heat and light. This principle is the foundation of an elegant means of lighting a match or taper, by causing the emission of the compressed air through an orifice. It proves also that heat is nothing but motion.

Almost all combustible bodies decompose it at a high temperature, which varies with the different substances. They absorb its oxygen with the disengagement of more or less heat and light, and form acids or oxides: phosphorus, however, combines at a low temperature with the oxygen and azote of the air, and produces, with the former, phosphorous acid; with the latter, phosphureted nitrogen or azote.

When the air is brought into contact with animal and vegetable substances, it changes them immediately, particularly if it is moist, and gives to some of them acid properties. It bleaches flax, hemp, silk, and increases the brilliancy of many colours. It is indispensable to the life of all organic beings; animals respire it incessantly, and decompose it; a part of its oxygen is transformed into carbonic acid, and this combination produces heat, which contributes principally to the preservation of animal heat. Vegetables imbibe the carbon, which the carbonic acid, diffused through the air, contains.

Five volumes of atmospheric air are composed of four volumes of azote of nitrogen, and one of oxygen exactly; For volumes of gases are as their weights, and a cubic inch of air weighs 0·305188 grains, and a cubic foot is 527·3661 grains.

A cubic inch of oxygen is 0·3390747 and a cubic foot 585·9554.

A cubic inch of nitrogen is 0·296704 grains and a cubic foot 512·706.

Then 1-5th 585·9554 = 117·1911
And 4-5ths 512·707 = 410·1648

Cubic foot of air as above = 527·3559 within the 100th of a grain.

The French chemists take the sp. gr. of oxygen as 1·10359 and nitrogen 0·96913 to air 1. We take water to air as 827·437 to 1 exactly.

AIR GUN. This is an instrument with a metal ball appended for holding a small magazine of air condensed to an 8th of its bulk by a syringe. When part of this air is let out, it explodes with force enough to pass a ball through an inch board, at 30 yards distance.

AIR, HEATED, for blast furnaces, are said to have been used for some time at the Clyde Iron Works, and with great success. Experiments have proved that iron is smelted by heated air, with three-fourths of the quantity of coal required, when cold air, that is, air not artificially heated, is employed for that purpose, while the produce of the furnace in iron is at the same time greatly increased. All the furnaces at Clyde Iron Works are now blown with it. At these works the air, before it is thrown into the blast furnaces, is heated to 220° of Fahrenheit, in cast iron vessels placed on furnaces, similar to those of steam-engine boilers.

Hot air may be obtained by placing a funnel or cone on a tripod, over a charcoal fire, or over an Argand lamp.

AIR PIPES, a recent invention of Sutton, for the ventilation of ships by means of the rarefying power of heat. If the usual aperture to any fire be closed up in front, and another be introduced by the side of the fire-place, it will direct the current of air into that situation; and the coppers, or boiling-places of ships, are well known to be placed over two holes, separated by a grate, the one for the fire, the other for the ashes; there is also a flue from the tops for the discharge of smoke. Sutton's pipes are introduced into the ash-place, and carried through the hold to any part of the vessel. The two holes before alluded to are closed up by strong iron doors; a continued draught of air supplies the fire, and creates a salutary circulation through any part of the vessel into which the pipes may be directed. They are made either of copper or lead.

AIR PUMP, a machine for the purpose of withdrawing the air from some vessel or cavity, and thereby making what is called a *vacuum*. The operation of the machine depends on the elasticity of the air, and a perfect vacuum cannot be formed by it in the receiver, as only a part of the air is each time expelled, and a portion must always remain after each depression of the piston. The degree of rarefaction produced by the machine may, however, be easily calculated. Suppose that the barrel contains one-third as much as the receiver and tube together, and, therefore, that it contains one-fourth of the whole air within the valve. Upon one depression of the piston, this fourth part will be expelled, and three-fourths of the original quantity will remain. One-fourth of this remaining quantity will in like manner be expelled by the second depression of the piston, which is equal to three-sixteenths of the original quantity. By calculating in this way, it will be found that, after 30 depressions of the piston, only one 3096th part of the original quantity will be left in the receiver. The rarefaction may thus be carried so far that the elasticity of the air pressed down by the piston shall not be sufficient to force open the valve.

To show how far the exhaustion has been carried at any point of the process, a barometer-gauge is connected with the machine. This is a glass tube, opening into the receiver, and immersed in a cistern of mercury. As the rarefaction proceeds, the mercury rises from the pressure of the external air, and indicates how far this pressure exceeds that from within the receiver, that is, the degree of exhaustion.

Both pistons are worked by a wheel and winch, by the rack or tooth-work on the piston-rods. When one piston is raised, the other is depressed. The winch is then turned in the opposite direction, and the piston which had been raised is depressed, and the other raised. When the rarefaction of the air within the barrels is considerable, the pressure of the atmosphere upon each piston is not resisted from within, and therefore opposes its ascent. But this pressure is not felt by the operator, as the pressure upon one piston counter-balances that upon the other. The elasticity of the air is proved by the action of the machine. Its pressure is proved by the great firmness with which the receiver is pressed upon the plate during the rarefaction of the air within.

If any animal is placed beneath the receiver, and the air exhausted, he dies almost immediately; a lighted candle under the exhausted receiver immediately goes out. Air is thus shown to be necessary to animal life and to combustion.

A bell suspended from a silken thread beneath the exhausted receiver, on being struck, cannot be heard. If the bell be in one receiver, from which the air is not exhausted, but which is within an exhausted receiver, it still cannot be heard. Air is therefore necessary to the production and to the propagation of sound.

A shrivelled apple or cranberry, placed beneath an exhausted receiver, becomes as plump as if quite fresh. They are thus shown to be full of elastic air.

To determine the number of strokes of a piston requisite to produce a desired rarefaction in air-pumps, divide the log. of the proposed rarefaction, as 50 or 100, by the log. of the fraction whose numerator is the contents of the receiver, and whose denominator is the joint contents of the receiver and barrel.

The exhaustion is in the ratio of the volume of the barrel of the piston to the volume under the receiver. If $\frac{1}{8}$ the reduction in one stroke is $\frac{1}{8}$th, and the remainder is $\frac{7}{8}$ths, the second stroke $\frac{1}{8}$th of $\frac{7}{8}$ths, or $\frac{7}{64}$ths, leaving $\frac{56}{64} - \frac{7}{64} = \frac{49}{64}$; the third $\frac{1}{8}$th of $\frac{49}{64}$ or $\frac{49}{512}$ leaving $\frac{49}{64} - \frac{49}{512} = \frac{392}{512} - \frac{49}{512} = \frac{363}{512}$, then the fractions of the remainder being $\frac{7}{8}$, $\frac{49}{64}$, $\frac{343}{512}$ &c. which are the powers of the number of strokes, so after 20 strokes it is $\frac{720}{820}$, and so for any number. In other words, for the $n$ th power it is log. $7 \times n$ — log $8 \cdot \times n$ as the ratio of 1 to the remainder, and so for any proportion or strokes. The limit of exhaustion is the power of the included air to raise the valve. A limit is also found in the imperfection of the machinery, the moisture, &c. &c. Cuthbertson's machine produces more perfect exhaustion, but is very complicated and too easily out of order. Others have been invented, as by Mendelssohn, &c. and no laboratory should be without one for miscellaneous applications. They are sold with varied apparatus, and at different sizes from six to thirty guineas, but as far as respects the powers and phenomena of common air the facts are before the world in 500 forms.

AIR TRUNK, a contrivance to prevent the stagnation of putrid effluvia in jails, or any apartments where many people are collected. It consists of a long, square trunk, open at both ends, one of which is inserted into the ceiling of the room, and the other extends a considerable distance beyond the roof. Through this trunk a continued circulation is carried on, because the putrid effluvia are much lighter than the pure atmosphere. Keil estimates these effluvia arising from one man, in 24 hours, at not less than 39 ounces. These trunks were first tried in the House of Commons, where they were nine inches wide within, and over the Court of King's Bench, where they were six inches wide.

AIR TUBES, for ventilation, depend on the principle of common air protruding rarefied air, so that if one end of an iron pipe is heated, foul air at the other end rushes onward to supply its place, and thus is carried off.

Such tubes, made of tin, ought to run from a corner of a ceiling to the roof, or the open air, in every room in which many persons sit, in which candles are burning, &c.; and, at other times, might be stopt with a plug, fixed to a long handle. This species of necessary ventilation would cost but a few shillings—not more than a noisy ventilator; and, being at the top of the room, would carry off all vitiated air.

ALABASTER, is a native rock, found in purity and magnitude near Rome, near Coblentz, and Cluny.

ALBUMEN, in physiology, exists nearly pure in the white of eggs. As thus procured, it is a glarous fluid, with very little taste. When kept for some time exposed to the air, it putrefies, but when spread in thin layers, and dried, it does not undergo any change. When heated, to about 165° Fah. it coagulates, and its properties are entirely changed. It is soluble in cold water, and is separated, in its coagulated state, by hot water, if the quantity of fluid be not great; but if the water be about ten times as much in amount as the albumen, there is no coagulation. Hence we cannot dissolve it in warm water, for, when put into it (as when a little of the white of eggs is thrown into a glass of boiling water), it is instantly coagulated. It is also coagulated by acids. Albumen exists in different parts of animals, as cartilage, bones, horns, hoofs, flesh, the membranous parts, and in considerable quantity in blood, from which it is usually procured, when required in the arts.

From the property which it possesses

of being coagulated by heat, it is employed for clarifying fluids, as in the refining of sugar, and in many other processes. When required in a large quantity, bullock's blood is used. When this, or the white of eggs, is put into a warm fluid, its albumen is coagulated, and entangles the impurities, and, as the scum rises, it is removed.

Albumen acts in the same way in clarifying spirituous fluids. When, for instance, the white of an egg is added to wine, or to any cordial, the alcohol coagulates it, and the coagulum entangles the impurities, and carries them to the bottom.

Both gelatin and albumen exist in flesh, and, as the former is soluble in warm water, hence the difference in the nutritious quality of butcher's meat, according to the mode of cooking it; when, for instance, meat is boiled, the greater part of the gelatin is extracted, and retained by the soup; when, on the contrary, it is roasted, the gelatinous matter is not removed; so that roasted meat contains both gelatin and albumen.

By the analysis of Gay-Lussac and Thenard, 100 parts of albumen are formed of 52·883 carbon, 23·872 oxygen, 7·540 hydrogen, 15·705 nitrogen.

The negative pole of a voltaic pile in high activity coagulates albumen. A proof that the negative pole is of the nature of alcohol or hydrogen, and that it is the hydrogen of water which produces the same effect.

Orfila has found the white of eggs to be the best antidote to the poisonous effects of corrosive sublimate on the human stomach.

ALBURNUM; the soft white substance which, in trees, is found between the liber or inner bark, and the wood, and, in progress of time acquiring solidity, becomes itself the wood. A new layer of wood, or rather of albernum, is added annually to the tree in every part, just under the bark.

ALCHEMY; the pretended art of changing, by means of a secret chemical process, base metals into precious. Probably the ancient nations, in their first attempts to melt metals, observing that the composition of different metals produced masses of a colour unlike either, for instance, that a mixture like gold resulted from the melting together of copper and zinc, arrived at the conclusion, that one metal could be changed into another. To transmute metals, they thought it necessary to find a substance which, containing the original principle of all matter, should possess the power of dissolving all into its elements. This general solvent, or *menstruum universale*, which, at the same time, was to possess the power of removing all the seeds of disease out of the human body, and renewing life, was called the *philosopher's stone*, *lapis philosophorum*, and its pretended possessors *adepts*. The more obscure the ideas which the alchemists themselves had of the appearances occurring in their experiments, the more they endeavoured to express themselves in symbolical language. Afterwards, they retained this phraseology, to conceal their pretended secrets from the uninitiated.

ALCOHOL is the product of a product, the distillation of fermented liquors, and various essential oils give it its flavour, in brandy, rum, whiskey, &c. Alcohol, obtained by slow and careful distillation, is a limpid colourless liquid, of an agreable smell, and a strong pungent flavour. Its specific gravity varies with its purity, the purest obtained by rectification over chloride of calcium being ·791; as it usually occurs, it is ·820 at 60°. If rendered as pure as possible by simple distillation, it can scarcely be obtained of a lower specific gravity than ·825 at 60°. Walker exposed it to a temperature of 91°, but no congelation took place; it has, therefore, been much used in the construction of thermometers. Even when diluted with an equal weight of water, it requires a cold of 6° below 0 to congeal it. When of a specific gravity of ·825, it boils at the temperature of 176°, the barometrical pressure being 30 inches. In the vacuum of an air-pump it boils at common temperatures. The specific gravity of the vapour of alcohol, compared with atmospheric air, is 4·613.

Alcohol may be mixed in all proportions with water, and the specific gravity of the mixture is greater than the mean of the two liquids, in consequence of a diminution of bulk that occurs on mixture. The strength of such spirituous liquors as consist of little else than water and alcohol, is of course ascertained by their specific gravity; and, for the purpose of levying duties upon them, this is ascertained by the hydrometer. But the only correct mode of ascertaining the specific gravity of liquids, is by weighing them in a delicate balance against an equal volume of pure water, of a similar temperature.

Alcohol is extremely inflammable, and burns with a pale-blue flame, scarcely visible in bright day-light. It occasions no fuliginous deposition upon substances held over it, and the products of its combustion are carbonic acid and water, the weight of the water considerably exceeding that of the alcohol consumed. According to Saussure jun. 100 parts of alcohol afford when burned, 136 parts of water, owing to the combination with oxygen. The steady and uniform heat which it diffuses by fixing oxygen, during combustion, makes it a valuable material for lamps.

The action between alcohol and some of the metals, particularly platinum, is remarkable. When a small piece of thin platinum leaf, suspended by a wire, is heated by a spirit lamp, and then quickly put into a glass, in which there is a little alcohol, so that it shall remain just over the surface, and of course, in the vapour arising from the alcohol, it continues red-hot, as long as there is any fluid in the jar; which is owing to the vapour undergoing a sort of combustion, and generating heat sufficient to keep the metal in that state. This action affords the means of making a lamp without flame.

There are some substances which communicate colour to the flame of alcohol; from boracic acid, it acquires a greenish-yellow tint; nitre and the soluble salts of baryta cause it to burn yellow, and those of strontia give it a beautiful rose colour; cupreous salts impart a fine green tinge.

Alcohol dissolves pure soda and potassa, but it does not act upon their carbonates; consequently, if the latter be mixed with alcohol containing water, the liquor separates into two portions, the upper being alcohol, and the lower the aqueous solution of the carbonate. The alcoholic solution of caustic potassa was known in old pharmacy under the name of Van Helmont's tincture of tartar. It is used for purifying potassa. Alcohol dissolves the greater number of the acids. It absorbs many gaseous bodies. It dissolves the vegetable acids, the volatile oils, the resins, tan and extractive matter, and many of the soaps; the greater number of the fixed oils are taken up by it in small quantities only, but some are dissolved largely.

The composition of alcohol was investigated by Saussure and Gay-Lussac. The result was, that 100 parts of pure alcohol consist of

| | | |
|---|---|---|
| Hydrogen...... | 13·70 | |
| Carbon........ | 51·98 | 100·00 |
| Oxygen........ | 34·32 | |

These numbers approach to 3 proportionals of hydrogen, = 3; 2 of carbon, = 12; and 1 of oxygen, = 8. Equivalent 23. Or it may be regarded as 1 vol. carbureted hydrogen, and 1 vol. of the vapour of water; the 2 volumes being condensed into 1, the specific gravity of the vapour of alcohol, compared with common air, will be 1·599, or according to Gay-Lussac, 1·613.

When alcohol is submitted to distillation with certain acids, a peculiar compound is formed, called *ether*, the different ethers being distinguished by the names of the acids employed in their preparation.

Alcohol, in its strongest state, is usually prepared by rectifying the common spirits over potash, muriate of lime, or quick-lime; but, since these additions partly change the nature of the spirit, Hermbstadt thinks, their utility in distillation is not so great as has generally been supposed. Duebac tried a variety of substances, the principal of which were, burnt stucco, calcined Glauber's salts, common salt heated, and potter's clay, of which the last appeared to answer best. To 12 ounces of clay, well washed, sifted, and strongly dried, he applied 32 ounces of spirit of wine, at 39° Beaumé, or sp.gr. 0·832, which, on being distilled, yielded alcohol at 42° Beaumé, or sp. gr. 0·820; and which, on being re-distilled, with potter's clay, became no lighter or pure alcohol. But that obtained by the application of potash and muriate of lime may be brought to 50° Beaumé, or the sp. gr. 0·782, owing to the formation of ether. Hermbstadt asserts, that by simply distilling brandy six times, without having recourse to any substance for the purpose of divesting it of its aqueous parts, he has obtained alcohol, sp. gr. of 0·8, or 46° Beaumé; and, of course, lighter than that purified by potter's clay.

In spirits of grain, wheat, as 3, is preferred to malt, as 1. Water is applied at 90°, and yeast, for it to ferment, at from 77° to 70°, for three days, till fine and pungent. The wash is then passed into a shallow still, and carried over, by a gentle heat, till half is consumed. The product is called *low wine* and *faints*; a second distillation is raw spirit, and the third rectified spirit, being 20 to the 100 gallons of wash, of which $\frac{6}{11}$ is alcohol, and $\frac{5}{11}$ water. Cyder yields 15 and molasses 22 to 100. Wines yield in similar proportions. Brisk wines, whose fermentation has been stopt early yield least alcohol. It ought to be without colour or flavour; but favourite colour and flavour being acquired by accident, they are then imitated by makers.

Spirit of nitre is used for flavour and burnt sugar and other articles, according to the fancy of the maker. Hollands are made of three wheat and one barley malt, rectified over juniper berries. In England, two ounces of oil of turpentine and a pound of bay salt is added to every 10 gallons, with aromatics for cordials and compounds. The purest wine alcohol is 829, though some profess to obtain it at 800. In the shops it is from 840 to 850. When shaken in a phial, the bead is as the strength. The standard, at 60°, is 825, which, at 30°, is 838·96, and 100 is 805·48.

As a chemical agent, it is of the highest importance, involving in its various combinations all the grand principles of chemistry. It has been found that spirit of wine, of sp. gr. ·867, when enclosed in a bladder, and exposed for some time in the air, is converted into alcohol of sp. gr. ·817, the water only escaping through the coats of the bladder.

The readiest practical method of determining the strength of *alcohol* is, to fill a large vial with it, and then to drop into it a small lump of potash, or pearlash, which has been heated very hot over the fire, to expel its moisture, and which has not afterwards been suffered to become cold; the vial is then to be well shaken, and if the lump remains dry, or nearly so, the alcohol is good; but if any considerable portion of it is dissolved, it is too weak.

Another mode of trying the strength of alcohol is by its *specific gravity*, or the weight of a certain bulk of it, compared with the same bulk of water. The greater its purity, the less it weighs, and when perfectly pure, its weight is but little more than four-fifths of that of water. Take a vial, which, when filled to a mark made on its neck, holds exactly 5 ounces of water; the same vial, filled with alcohol, to the same mark, ought to contain but a fraction more than 4 ounces. For practical use, the foregoing method is sufficiently correct, and may readily be employed.

*To make pure Alcohol.*—Add 1 lb. of subcarbonate of potass, heated to 300°, to 1 gallon of rectified spirit, and macerate for 24 hours, occasionally shaking the vessel. Pour off, and add 2 lbs. of subcarbonate of potass at 300°. Then distil in a water-bath, and preserve in close bottles. Or, for the subcarbonate, add 3½ lbs. of hot pearlashes, digest in a close vessel for a week, frequently shaking; then add 1 lb. of powdered muriate of lime, and distil with a moderate heat. This last produces alcohol, at 810, and even below 800; when in 100 parts, it retains but 2 or 3 parts of water. At 915 it is half water. The London and Dublin Pharmacopœas suppose it to be 815, with 7 of water; the Edinburgh 835, with 15 of water. Proof spirit, in London and Edinburgh, is 930, or 56 water and 44 alcohol.

Alcohol is spirits of wine, distilled with dry carbonate of potash or chloride of calcium. Thus procured, its sp. gr. at 60° is 0·7946. Mixed with water, the sp. gr. is higher than the mean. 3 water to 1 alcohol, which ought to be 0·89373, rises to 0 91662. It boils at 173 ·5. Its vapour is 1 vol. of steam and 1 of olifiant gas; and it is decomposed into water and olifiant gas. It consists of three atoms of hydrogen (3,) two of carbon (12,) and one of oxygen (8,) = 23, as the equivalent.—*See* DISTILLATION and FERMENTATION.

*Alcohol with laurel-oil.*—To exhibit a singular spectacle, take a vial of laurel-oil and drop into it, at different intervals, some rectified spirits of wine, when the most interesting results will be observed to ensue; a circulation presently commencing, of globules of alcohol up and down through the oil, which will last for many hours, or for days. A revolving or circulating motion also appears in the oil, the round bodies moving freely through the fluid, turning short in a small eccentric curve at each extremity of their course, passing each other rapidly without touching; but, after a time, they seem to acquire a density approximating to that of the lower stratum, which appears to be an aqueous portion, separated by the ethereal oil from the alcohol; and this assimilation taking place, the globules, after performing many revolutions, will fall flat upon the surface, and unite with the lower or watery stratum. The orbits of those small globules being confined by the glass are very eccentric. In the course of the experiment, particles of the fluid are observed to separate in larger globular portions; these commenced a similar revolution, and smaller ones quitted their course and revolved about the larger, whilst the latter still pursued their course after the manner of primary planets and their secondaries. This, however, can only be well understood by seeing the experiment, which is easily performed, and well worth the trouble. In the present case, the revolving motion of these globules appeared to be, not as we are accustomed to regard the planetary motions, as the effect of a direct attractive and repulsive power, in combination with a projectile force, but as revolving in a circulating medium, attended by an emanation from the globules themselves.

The alcohol is the same in all spirits, and flavours arise from the substances employed by rectifiers.

ALDER (*betula alnus*), is a tree which grows in wet situations; and there are no means of better employing swampy grounds. The growth of them is not rapid, but the wood is in great demand for machinery, and as cogs for water-wheels, as it is peculiarly adapted. It is used for pumps, sluices, pipes, drains, and conduits, and for the foundation of buildings situated in swamps.

It is also commonly used for bobbins, women's shoe-heels, and ploughmen's clogs; also for many domestic and rural uses, as spinning-wheels, troughs, the handles of tools, ladders, cart-wheels, &c. The roots and knots furnish a veined wood, of the colour of mahogany, well adapted for cabinet-work.

The bark is used in tanning and leather-dressing, and by fishermen, for staining nets, and this and the young twigs are sometimes employed in dyeing shades of yellow and red. With the addition of copperas, it yields a black dye, used to a considerable extent in cotton dyes.

Alder-tree, black (*alnus nigra*).—The unripe berries are used to make sap-green. The ripe berries are purgative. The bark bitter, emetic, detersive, aperitive, and dyes yellow. The bark of the root is violently purgative. The wood, black dog wood, makes the best charcoal for gunpowder.

ALE, the superior beverage of the English people, a secondary one being porter, and the inferior small beer. The difference between ale and beer is merely in the strength, both being products of pale malt; and porter is, or ought to be, a product of brown or high-dried malt, made deeper in colour by sundry ingredients. Ale in England is generally brewed with five, six, or eight bushels of malt to the hogshead of 63 gallons, and 1 lb. of Kentish hops to every bushel of malt. The liquor or water being raised to 180° or 185°, and the boiling of the worts kept up for two hours. It is then fermented at 75°, and worked for two or three days. Small beer is generally made of one-third the quantity of malt or from the grains or goods of the ale. Porter is seldom brewed by private persons, but in some of the largest establishments in the kingdom, and malt and hops are its professed bases, but its colour and flavour are altogether artificial.—Gross legislative ignorance of the habits of the people led to a late adoption of some odd article called intermediate or Scotch beer, but it was not adopted. The same legislative ignorance led to the taking off of the duty on beer instead of taking it off malt, so that though beer fell in price nothing was gained in quality, and private brewing has been discouraged by the high duty on malt.

Gray states that 14 quarters of pale malt, mashed at three times with 28, 18, and 18 barrels of water, boiled with one cwt. of hops, and set with 36 lbs. of yeast, and cleansed with 4 lbs. of salt, will produce 34 barrels of good ale; or after the rate of one gallon and a pint for every gallon of malt.

Strong ale-wort should be a tenth heavier than water, either by the hydrometer or by weighing 10 parts against 11 parts. Weak ale 1-16th. Table beer 1-20th.

Good porter is brewed with seven quarters of pale malt, six of amber malt, and three of brown malt; mashed at twice with 56 and 48 barrels; boiled with 113 lbs. of Kentish hops, tunned with 80 lbs. of yeast, and cleansed with 4 lbs. of salt and ½ lb of flour. The produce 56 barrels, or 3½ gallons of porter for 1 of malt.—*Gray.*

Six pounds of sugar in beer is deemed equal to a bushel of malt in strength or body; and 1 lb. of coriander seed equal in intoxicating power.

New beer is made to taste like stale by adding a little sulphuric acid, or alum; and stale or sourish beer is made like new beer by adding powdered chalk or oyster-shells.

The colouring used by brewers consists of brown sugar burnt till bitter, and then made into syrup with lime-water.

Brewers also use *bittern*, consisting of extract of coculus indicus, extract of quassia, Spanish liquorice, and calcined sulphate of soda. Also *multum*, consisting of extract of quassia and liquorice root. And *bitter balls*, made of powdered gentian 8 lbs. extract of gentian 4 lbs. and treacle to mix.

When publicans in drawing reduce strong beer by mixing small beer, they add molasses to form a head and extract of gentian to keep up the flavour, but by adding too much gentian they often make it too bitter, or by too much molasses very ropy.

Many brewers meet the demand of the vulgar for an intoxicating power (the object being to get drunk with the smallest quantity) by infusing opium, cocculus indicus, nux vomica, tobacco, and poppy heads. Others, to render it pungent, add capsicum and grains of paradise, and then introduce ginger, coriander seed, and orange-peel to disguise the new flavours.—*See* Beer.

Ale *(from mangel wurzel.)* About ten pounds of the root to a gallon make good liquor; but with fifteen pounds weight to the gallon, excellent ale is produced; and the addition of two pounds' weight of treacle to a firkin will be a great improvement. One-third malt and two-thirds mangel wursel liquor make capital ale. First to mash and clean the roots, take off the top completely, scrape (or pare) off the outer rind, slice and boil them until soft and pulpy; squeeze the liquor from the pulp as much as possible, and then boil it again with about six ounces of hops to nine gallons, and work with yeast in the usual way. The leaves, stripped from the plant in August and September, are valuable for the cow or pig, and the roots, boiled and mashed in the liquor, with either milk or a small quantity of meal added, will feed a pig at a trifling expence. The culture is simple. Let single seeds be put on well-manured ridges, eighteen inches apart, and six or eight inches between the plant, and hoeing down and keeping clean from weeds is all that is necessary.

Ale *(from sugar.)* For 10 gallons the proper quantity of hops is about $1\frac{1}{4}$ lb. On this quantity, pour on 11 gallons of boiling water; or, boil the hops in the water for about five minutes, then in the strained liquor dissolve 14 lbs. of sugar, and mix in a pint of yeast of the best quality. Pour the whole into the cask: it will soon begin to ferment; it will throw up its yeast through a cork-hole at top. It will require three weeks or a month to complete the fermentation. For the last fortnight the cork may be generally kept in the hole; but it should, once every two days, be removed, to give vent. When the fermentation appears at an end, the cork may then be permanently driven in, and in four days the ale will be fit for draught, or for bottling. White sugar affords ale scarcely coloured; brown sugar imparts proportionate colour, and not quite so pure a flavour. Should colour be an object, it may be communicated by the raspings of an over-baked loaf, or by scorched treacle. The drink will spontaneously fine itself. Hops are not the only bitter, others can much more conveniently be procured in certain situations, as wormwood, powdered bitter oranges, gentian root, and rind of Seville oranges, will afford an excellent bitter, perhaps more wholesome than hops.

Ale *(potatoe.)* The potatoes are to be grated to a pulp, and mixed with boiling water, and some ground barley-malt is to be added. The liquid is to be hopped in the usual way, yeast added, and the fermentation induced. In Ireland excellent beer is brewed from *parsnips*, by a process like the foregoing, but no malt is used, and the bitter is hops.—*See* Fermentation and Beer.

ALEGAR, is vinegar made by working good ale upon the cuttings of vines, unripe grapes, or cheap raisins, in three casks, as in making wine vinegar.

ALEMBICS, are distilling and subliming vessels used in chemical operations, and very convenient even as appendages to common kitchens. They consist of a body, a head, a beak, and a receiver, and are a species of large retort.

Alembics differ from retorts in being generally composed of two pieces, the cucurbit, or body, into which the materials to be distilled are introduced, and the capital, or head, in which the vapours are condensed, and which fits closely on the top of the body, which is cut so as just to rise above the channel of the head. The capital, or head, has its external circumference, or base, depressed lower than its neck; so that the vapours which rise, and are condensed against its sides, by the contact of the surrounding air, runs down into the circular channel formed by its depressed part, from whence they are conveyed by the beak, or nose, on the side of the head or capital, into the receiving apparatus.

The capital is sometimes stoppered, or pierced with a small opening at the top, furnished with a ground stopper. This contrivance is convenient for introducing, from time to time, a fresh supply of materials intended to be distilled, without deranging the apparatus. The capital, or head, is sometimes made air-tight to the body by grinding, or even made of one piece with it; but this method is expensive, and little, if at all, superior to closing the joint by lute. Some direct the neck of the head to be placed within the mouth of the body; but this would require them to be always ground together; when the fleck is blown of a proper roundness, it fits the outside of the body so as to require scarcely any lute.

Alembics has an advantage over retorts that the residues of distillation may be easily cleared out of the body. They are likewise capable, when skilfully managed, of distilling a much larger quantity of liquid in a given time, than a retort of equal capacity. Besides, the alembic may be used for causing the vapour of bodies to act upon substances in a more convenient manner than can be done by means of a retort and receiver.

Glass bodies of Alembics are usually made from one pint to two gallons capacity; and are occasionally pierced, and even stoppered on the side, at about half their heighth. They are sometimes made of earthenware, or pewter, and the head only of glass; or of iron, with a stoneware head. But a silver body, with a glass head, is necessary for the preparation of the pure fixed alkalies; and a silver head for preparing fluoric acid. Platinum bolt-heads, with heads of the same metal, are also used in the concentration of oil of vitriol.

These alembics are very expensive in the first instance; but the frequent accidents which happen, in concentrating the acid in glass, counterbalance the expense.

*Glass matrasses*, with glass heads, are also used as *alembics*, and the heads are generally of white glass and stoppered. And a series of heads, the lower being open at top, are sometimes placed one on another, by which the operator hopes to procure the distilled liquor of different strengths, according to the height which the vapours rise. Other chemists have endeavoured to send over only the most volatile parts into the receiver, and to let the other return into the body; for this purpose, some used a long winding neck to the body, on which the head was fitted. Others have prolonged the top of a blind head to a great length, and brought it down again, in a similar winding course, to a level with the other part of the head.

All glass vessels which are exposed to heat, require management to prevent breaking. If any solid substance be put into a retort, or body, and adheres to the bottom when over a lamp, it is almost sure to break. If a glass retort be laid down, while hot, upon a substance capable of conducting away the heat from it rather quickly, it will break; but it may be laid down upon a piece of woollen cloth, straw, or on dry glass, or even very dry sand.

The *receivers* of Alembics are large glass globes, with short and wide necks, A large condensing surface renders the operation more profitable and safe. These *adapters* are pipes of white glass, about two feet long, one end of which is fitted to embrace the neck of the retort, and the other to fit into the neck of the receivers.

Receivers are generally made of green glass, but when white glass adapters are used, stone-ware jugs of sufficient size may be used for receivers.

As the substances disengaged by heat are sometimes not condensible, even by putting water or other liquids into the receiver, a passage must be left for them. Some, before luting, put a piece of stick between the joint of the retort or adapter and the receiver, and take it out occasionally; but the more ordinary method is for the chemist himself to make an opening on the globular part of the receiver, taking care in placing it that this hole is uppermost. For common purposes the hole is stopped with a bit of stick, and hindered from falling in by a collar, or with a piece of soft wax.

If it is supposed that the vapour is condensible, although with difficulty, a long and wide barometer cane is luted into this hole, so that the atmosphere acts like a stopper on the vapour: steam, and air, not easily mixing together, but remaining perfectly distinct in pipes.

For the purpose of taking away a part of the liquid product, during the progress of the operation, without the necessity of unluting the joints, some receivers have a short pipe, called a quill, on their sides; so that the liquid that comes overflows thus into a bottle placed to receive it.—*Gray.*

ALGEBRA, or Abstract Arithmetic, is as great an advance on arithmetic as arithmetic is on ignorance of figures. Any letter, at pleasure, is put for any number, and then the letters are worked by the four rules, till a simple result is attained; thereby saving all the intermediate operations. $+$ put between two letters, as $a + t$, means that $a$ and $t$ are added. $-$ put, means, that one is taken from the other, as $a - t$. $\times$ between them, means that they are multiplied, as, $a \times t$; which is more commonly expressed by joining them, as $at$. $\div$ put between, means, that $a$ is divided by $t$, as $a \div t$; but more commonly expressed as a fraction, $\frac{a}{t}$.

Then, by very simple methods for the four rules, results of questions and problems may be solved which cannot be approached by arithmetic, or, if so, not without prolix operations. If arithmetic were taught decimally, boys, in general, might acquire algebra and arithmetic in the time that is usually spent on arithmetic.

The other signs used in algebra are,
$=$ for equal.
$\sqrt{}$ for square root.
$\sqrt[3]{}$ for cube root, &c.
$a^2$ for square of $a$.
$a^3$ for cube, &c.
Or, $a^{\frac{1}{2}}$ or $a^{\frac{1}{3}}$ for square or cube root.

ALIMENT; a term which includes every thing serving as nutriment for organized beings. In animals and vegetables we can observe the phenomena of decomposition and reproduction, and analyze the substances that administer to their growth and repair distinctly. Generally, the word Aliment is used for what serves as nutriment to animal life. It is, in this respect, a subject of great interest. Man, it is well known, derives nourishment both from animal and vegetable substances. He eats fruits, both ripe and unripe, roots, leaves, flowers, and even the pith and the bark of different plants, many different parts of animals, and the whole of some. Climate, custom, religion, the different degrees of want and of civilization, give rise to an innumerable diversity of food and drink; from the diet of the carnivorous native of the north, to that of the Brahmin, whose appetite is satisfied with vegetables; from the oak-bark bread of the Norwegian peasant, to the luxuriously-served table of a Hungarian magnate at Vienna.

Some nations abhor what others relish, and great want often renders acceptable what, under other circumstances, would have excited the greatest disgust. The flesh of dogs is commonly eaten in China, and in Africa that of snakes, particularly of the rattle-snake and boa constrictor. Locusts are eaten both in Asia and Africa, and the Negroes on the coast of Guinea relish lizards, mice, rats, snakes, caterpillars, and other reptiles and worms. The Otamacs, a tribe of American Indians, are said by Humboldt to collect a kind of clay, to eat in the rainy season.

All kinds of aliment must contain nutritious substance, which, being extracted by the act of digestion, enters the blood, and effects by assimilation the repair of the body. Alimentary matter, therefore, must be similar to animal substance, or transmutable into such. In this respect, alimentary substances differ from medicines, because the latter retain their peculiar qualities in spite of the organs of digestion, and will not assimilate with the animal substance, but act as foreign substances, serving to excite the activity of particular organs or systems of the body.

All alimentary substances must be composed, in a greater or less degree, of soluble parts, which easily lose their peculiar qualities in the process of digestion, and correspond to the elements of the body. These substances, in their simple state, are mucilage, gelatin, gluten, albumen, farina, fibrin, and saccharine matter. Of these, vegetables contain chiefly mucilage, saccharine matter, and farina, which latter substance, particularly in connexion with the vegetable gluten, by which both become apt for fermentation, and thus for dissolution and digestion, is the basis of very nutritious food. The nutritive part of fruits consists of their saccharine matter and a little mucilage.

The nutritiousness of the different species of food and drink depends, therefore, upon the proportion which they contain of those substances, and the mode in which they are connected, favouring or obstructing their dissolution. Organs of digestion, in a healthy state, dissolve alimentary substances more easily, and take up the nutritious portions more abundantly, than those of which the strength has been impaired, so that they cannot resist the tendency of each substance to its peculiar chemical decomposition.

The wholesome or unwholesome character of any aliment depends, in a great measure, on the state of the digestive organs, in any given case. Sometimes a particular kind of food is called wholesome, because it produced a beneficial effect of a particular character on the system of an individual. In this case, however, it is to be considered as a medicine, and can be called wholesome only for those whose systems are in the same condition.

Very often a simple aliment is made indigestible by artificial cookery. Aliments abounding in fat are unwholesome, because fat resists the operation of the gastric juice. The addition of too much spice makes many an innocent aliment injurious, because spices resist the action of the digestive organs, and produce an irritation of particular parts of the system. They were introduced as artificial stimulants of appetite. In any given case, the digestive power of the individual is to be considered, in order to determine whether a particular aliment is wholesome or not. In general, therefore, we can only say, that that aliment is healthy which is easily soluble, and is suited to the power of digestion of the individual; and, in order to render the aliments perfect, the nutritious parts must be mixed up with a certain quantity of innocent substance affording no nourishment, to fill the stomach, because there is no doubt, that many people injure their health by taking too much nutritious food. In this case, the nutritious parts which cannot be dissolved act precisely like food which is in itself indigestible. The kind of aliment used influences the health and even the character of man. Experience proves that animal food disposes the body to inflammatory, putrid, and scorbutic diseases, and the character to violence and coarseness. On the contrary, vegetable food renders the blood lighter and more liquid, but forms weak fibres, disposes the system to the diseases which spring from feebleness, but tends to produce a gentle character. Something of the same difference of moral effect results from the use of strong or light wines. But the reader must not infer that meat is indispensable for the support of the bodily strength.

In fact, the aliments of nature are the elements for minerals; minerals for vegetables; and vegetables for animals. But, in climates and situations where vegetables are scarce, ferocious animals from necessity eat up other animals as a short way of subsisting, provided they have the power to overcome them, or the art to ensnare them. In general, animals that feed on vegetables live much longer and with fewer diseases than those that feed on other animals, while the practice of killing blunts the moral and sensitive feelings, and the eating of them betrays a want of delicacy and sentiment.

The peasants of some parts of Switzerland, Ireland, and Scotland, who hardly ever taste any thing but bread, cheese, and butter are vigorous people.

Prout, Lamb, &c. consider the principal alimentary substances as reducible to three great classes, the *saccharine*, the *oily*, and the *albuminous;* which, with certain exceptions, includes the substances in which, according to Gay Lussac and Thenard, the oxygen and hydrogen are in the same proportion as in water. Such substances are principally derived from the vegetable kingdom, and being, at the same time, alimentary, Dr. Prout considers the terms saccharine principle and vegetable aliment as synonymous. The following table shows some of that eminent chemist's results with several substances, and extreme care was taken, in every case, to obtain the bodies pure.

SUGAR.

| | *Carbon.* | *Water.* |
|---|---|---|
| Pure sugar-candy | 42·85 | 57·15 |
| Impure sugar-candy | 41·5 to 42·5 | 58·5 to 57·5 |
| East India sugar-candy | 41·9 | 58·1 |
| English refined sugar | 41·5 to 42·5 | 58·5 to 57·5 |
| East India refined sugar | 42·2 | 57·8 |
| Maple sugar | 42·1 | 57·9 |
| Beet-root sugar | 42·1 | 57·9 |
| East India moist sugar | 40·88 | 59·12 |
| Sugar of diabetic urine | 36· to 40 ? | 64· to 60 ? |
| Sugar of Narbonne honey | 36·36 | 63·63 |
| Sugar from starch | 36·2 | 63·8 |

AMYLACEOUS PRINCIPLE.

| | *Carbon.* | *Water.* |
|---|---|---|
| Fine wheat starch | 37·5 | 62·5 |
| dried (1) | 42·8 | 57·2 |
| highly dried (2) | 44 | 56 |
| Arrow root | 36·4 | 63·6 |
| dried (3) | 42·8 | 57·2 |
| highly dried (4) | 44·4 | 55·6 |

(1) Dried between 200° and 212° for 20 hours, lost 12·5 per cent.
(2) Part of the former, dried between 300° and 350° for six hours, 2·3 per cent.
(3) Dried as (1), lost 15 per cent.
(4) Part of the last, heated to 212° for six hours longer, lost 3·2 per cent. more.

ALKALI, in chemistry; from the Arabian *kali*, the name of a plant from the ashes of which one species of alkali can be extracted. The substances that are met with under the denomination of alkaline, are possessed of certain peculiar properties. They are mainly characterized, however, by a power of combining with acids in such a manner as to impair the activity of the latter, so that alkalies, as chemical agents, are distinguished by properties the reverse of acids; acids and alkalies are, therefore, generally considered as antagonist substances.

Besides the power of neutralizing acids, and thereby forming certain saline substances, the alkalies are further distinguished by the following properties:—1. They have an acrid taste and corrosive power when applied to some substances, thus proving caustic to the skin and tongue. 2. They change vegetable blue to green, red to purple, and yellow to a reddish-brown (if the purple be reddened by an acid, an alkali will restore the original colour). 3. They are almost indefinitely soluble in water; that is, they combine with it in every proportion. 4. They unite with oils and fats, and form by this union the well-known compound called *soap*.

There is another class of substances which have a strong analogy with alkalies, especially in the particular of opposition to acids, viz. *the earths.* Some of these, indeed, have been classed by Fourcroy among the alkalies, but they have been kept separate by others, on the ground that the analogy between them is far from amounting to complete identity of properties.

The true alkalies have been arranged by a modern chemist in three classes:—1. Those which consist of a metallic basis, combined with oxygen; these are three in number, potash, soda, and lithia. 2. That which contains no oxygen, viz. ammonia. 3. Those containing oxygen, hydrogen, and carbon; in this class are placed aconita, atropia, brucia, circuta, datura, delphia, hyoscyamia, morphia, strychina, &c. &c. It is supposed that the vegetable alkalies may be found to be as numerous as the vegetable acids. The original distribution of alkaline substances was into volatile and fixed, the volatile alkali being known under the name of *ammonia*; while, of the two fixed kinds, one was called *potash* or *vegetable*, because procured from the ashes of vegetables generally; the other,* *soda* or *mineral*, on account of its having been found native, as well as obtained from the incineration of marine plants only.

Alkalies are determined in strength by their neutralization of acids. 7 lbs. of sulphuric acids, sp. gr. 1·8485, exactly neutralize 10 lbs. of carbonate of potash, $\frac{66}{7}$ lbs. of potash, $\frac{75}{7}$ lbs. of carbonate of soda, and $\frac{44}{7}$ lbs. of pure soda. —*See* Ammonia, Nitre, Potass, Soda, Atomic Theory.

Alkalies, value of.—The apparatus consists of a glass jar, about one inch in diameter, containing about five cubic inches, and graduated into inches and tenths; a dropping tube, about seven or eight inches long, divided into thirty equal parts; a porcelain mortar and pestle; a weight of 100 grains, and a bottle of sulphuric acid, so diluted that the quantity contained in 22 divisions of the dropping tube will just saturate 50 grains of crystallized subcarbonate of soda. To determine the point of saturation, litmus paper may be used, or, what is more convenient, infusion of cabbage.

The sample to be examined having been pounded sufficiently to pass through a coarse sieve, rub up some of it in the porcelain mortar, until it be reduced to a very fine powder; from this weigh 100 grains, and return it into the mortar; add thereto boiling water, a small quantity at a time, and continue to rub it as long as any grittiness appears under the pestle; suffer it to stand a short time, and pour off the liquid into a pint or half-pint vessel, with a lip. Add more boiling water to what remains, and again use the pestle, repeating this, to ensure the perfect solution of all the soluble part of the sample, until about half a pint of boiling water has been employed; transfer the whole into the same vessel, stir it well together, and allow it to stand for the insoluble part to subside; when this is effected, measure off the clear liquor by pouring it into the graduated jar, and set it by for use; measure also the remainder, first shaking it up, and having noted the total quantity, this remainder may be thrown away. Take of the clear solution just one-half of the whole amount of the two quantities, and add thereto about a table spoonful of the infusion of cabbage; then, having filled the drooping tube to the upper division with the test acid, drop so much into the sample, (constantly stirring the mixture) as will just change its green colour to crimson. The quantity of acid used, as indicated by the divisions on the tube, will show the per centage of alkali in the sample, if it be barilla, kelp, or manufactured soda; but, if the sample be pot or pearl ashes, augment the proportion of test acid used, by adding to the number of divisions indicated by the dropping tube, one-half such number, and the total will be the per centage of alkali in such sample.

Should it be desired to ascertain the quantity of carbonic acid contained in the sample, we need only note the point at which the solution becomes blue in the foregoing process, and deduct the divisions then indicated by the test tube from the subsequent total amount. Every ten of the remainder will then indicate seven per cent. of carbonic acid, whether of barilla or of potash.

*To ascertain the presence of Alkali in water:* evaporate a quarter of a pint over a chemical lamp, and add a drop of water to the residue, and test it by turmeric paper, which will be converted from yellow to brown if an alkali be present.

Modern chemists reckon 43 alkalis with a simple base, including the oxides of the metals, besides chlorides, bromides, &c. &c.

ALKALIMETERS. The strength of the two subcarbonates of soda and of potash is ascertained by the sulphuric acid, which a solution of 100 gr. requires for its neutralization. Tubes are sold which are graduated into 100 parts, containing the quantity of acid to saturate 100 grains of the pure subcarbonates, and are called *Alkalimeters*. The method of the German soap-boilers is, to pour a quart of water upon a pound of ashes, and then put in a piece of common soap, adding water in small portions till the soap sinks, and, of course, the ashes are stronger as they require more water.

ALKANET is a dyeing drug, the bark of a root which produces a rough plant (*anchusa tinctoria*,) with downy and spear-shaped leaves, and clusters of small, purple, or reddish flowers. The greater portion of the Alkanet is imported either from the Levant, or from the neighbourhood of Montpellier. It imparts a deep-red colour to unctuous substances and spirit of wine; but tinges water with a dull brown.

Its chief uses is coloring oils, plasters, lip-salve, and similar articles. It is likewise employed in rubbing and giving colour to mahogany furniture. Wax, tinged and applied to the surface of warm marble, stains it a flesh-colour, which sinks deep into the stone.

ALKERMES. In 28 pints of white cogniac brandy infuse 1 lb. of bay leaves, 1 lb. of mace, two ounces of nutmegs and of cinnamon, and 6 drams of cloves, three weeks; then strain, and distil twenty-four pints. Afterwards add 18 pounds of syrup of kermes (formed by dissolving 4 of white sugar in 1 of juice of kermes.)

ALLOY, a composition, the result of a mutual combination of two or more metals. To alloy generally, means to mix a metal of less with one of more value.—Various processes are adopted in the formation of alloys, depending upon the nature of the metals. Many are prepared by simply fusing the two metals in a covered crucible. It has been a question whether alloys are to be considered as compounds, or as mere mixtures. Dalton considers alloys to be chemical compounds, one striking instance of which is in the alloy of tin and copper, called *speculum metal*; the smallest deviations from the true proportions will spoil the alloy as a reflector. In some cases, the metals are found to unite in definite proportions only; and it is probable that all the alloys contain a definite compound of the two metals.

The principal characters of the alloys are the following:—1. We observe a change in the ductility, malleability, hardness, and colour. Malleability and ductility are usually impaired, and often in a remarkable degree; thus gold and lead, and gold and tin, form a brittle alloy. The alloy of copper and gold is harder than either of its component parts; and a minute quantity of arsenic added to copper renders it white.—2. The specific gravity of an alloy is rarely the mean of its component parts; in some cases an increase, in others a diminution of density having taken place.—3. The fusibility of an alloy is generally greater than that of its components. Thus platinum, which is infusible in our common furnaces, forms, when combined with arsenic, a very fusible alloy; and an alloy of certain proportions of lead, tin, and bismuth is fusible at 212°, a temperature several degrees below the melting point of its most fusible constituent.—4. Alloys are generally more oxydizable than their constituents taken singly; a property which is, perhaps, partly referable to the formation of an electrical combination.

From early times, the baser metals have been used to alloy gold and silver coins, to prevent loss by wear. In England, the legal proportion of base metal for gold coin is 1 part in 12 gold, and for silver coin 3 parts in 40 silver.

In France, the legal proportions of the different coins are as follows: silver coin, 9 parts silver, 1 copper; copper money, 4 parts copper, 1 silver; gold coin, 9 parts gold, 1 copper.

For *silver plate*, the French proportions are 9½ parts silver, ½ copper; for trinkets, 8 parts silver, 2 copper. For gold plate, they have three different standards; 92 parts gold, 8 copper; also 84 gold, 16 copper, and 75 gold, 25 copper.

Eleven parts of gold, that is, *standard gold*, the specific gravity of which is 19, when mixed with one part of copper, produce an alloy, the specific gravity of which is about 17; of this alloy, 20 pounds troy are coined into 934½ sovereigns, or 15 pounds into 700 sovereigns. One pound was formed into 44½ guineas, but now is coined into 46 sovereigns.

The Mint standard of gold is *3l.* *17s.* *10½d.* per ounce, or *46l.* *14s.* *6d.* per troy lb. It, in the late war, being exported for loans, &c. it rose to *5l.* per ounce.

*Standard Silver.*—11 ounces 2 pennyweights of fine silver and 18 pennyweights of alloy in a pound troy.

*Gold Solder.*—Pure gold 12 pennyweights; pure silver 2 pennyweights; and copper 4 pennyweights.

*Silver Solder for Jewellers.*—19 pennyweights of fine silver; copper 1 pennyweight; and of brass 10 pennyweights.

*Silver Solder for Plating with.*—10 pennyweights of brass and 1 ounce of pure silver.

*Ring Gold.*—Fine copper 6 pennyweights and 12 grains, 3 pennyweights and 16 grains of fine silver, to 1 ounce 5 pennyweights of gold coin. This is worth about £3 per ounce.

*Gold from 35s. to 40s. per ounce.*—8 ounces 8 pennyweights of fine copper, 10 pennyweights of fine silver, to 1 ounce of gold coin.

*Manheim Gold, or Similor.*—3½ ounces of copper, 1½ ounce of brass, and 15 grains of pure tin.

*Pinchbeck.*—1 ounce of brass, 1½ ounce or 2 ounces of copper, fused together under a coat of charcoal dust.

*Prince's Metal.*—3 ounces of copper and 1 ounce of zinc, or 8 ounces of brass and 1 ounce of zinc.

*Bell Metal.*—100 parts of copper mixed with from 20 to 25 parts of tin.

*Gun Metal.*—100 pounds of copper and 12 pounds of tin, either with or without a little brass.

*Best hard white Metal for Buttons.*—1 pound of Bristol brass, 2 ounces of zinc, and 1 ounce of block-tin.

*Common hard white Metal.*—1 pound of brass, 1½ ounce of zinc, and half an ounce of tin.

*Bath Metal.*—1 pound of brass and 4½ ounces of zinc.

*A white metal.*—2 pounds of regulus of antimony, 8 ounces of brass, and 10 ounces of tin.

*Hard Solder.*—2 pounds of copper to 1 pound of tin.

*Soft Solder.*—Two-thirds of tin and one-third of lead.

*Printer's Type.*—Lead, hardened by antimony, with some copper and brass.

*Hard Pewter.*—12 ounces of tin, 1 ounce of regulus of antimony, and 2 drachms of copper.

*Tutania.*—8 ounces of brass, 2 pounds of regulus of antimony, and 7 ounces of tin.

*A metal for speculums or Mirrors.*—Copper 32 parts, tin 15, brass 1, silver 1, and arsenic 1.—*Richardson.*

ALLOY *for plating Iron, and protecting it from rust*, called *Artimomantico.* It is easily applied, and forms an amalgam with the iron, penetrates to some depth, and effectually protects it from rust. It derives this property from its refusing to unite with oxygen at common temperatures, or even when artificially heated. It is formed out of many metals. It does not increase the hardness of the article to which it is applied, nor does it efface the finest lines on the surface, and it does not injure the temper of knives. Four ounces is sufficient to cover an iron bedstead; and twelve ounces are valued at 7*s.* A company has been formed lately at Bologna, for coating iron work, and they are now drawing out plates, which can be united to one another by heat, without any injury to the coating.

ALLSPICE, or PIMENTO, is the berry of a species of myrtle (*myrtus pimenta*) 20 feet high and upwards, with oval leaves, about four inches, and numerous branches of white flowers, each with four petals. No tree is more beautiful or more fragrant than a young pimento-tree. Pimento-trees grow spontaneously, and in great abundance, in many parts of Jamaica, &c. In propagation the usual method is to appropriate a piece of woody ground in a part of the country where the trees are found in a native state. The other trees are cut down, and, in a year or two, young pimento-plants spring up in all directions.

About September, after the blossoms have fallen, the berries are fit to be gathered. Though not ripe, they are full grown, and the size of pepper-corns. One picker will get 70 pounds per day. The berries are then spread in the sun, and by the drying they lose their green colour, and the process is completed by their change of colour, and by the rattling of the seeds in the berries. When the berries are ripe, they are dark-purple and filled with sweet pulp. Pimento resembles in flavour a mixture of cinnamon, nutmegs, and cloves, and hence has obtained the name of *all-spice.*

It is much employed in cookery and in medicine, as an agreeable aromatic, and forms a distilled water, a spirit, and an essential oil. The leaves yield an odoriferous oil, frequently used instead of the oil of cloves.

ALMOND-TREE, (*amygdalus communis.*) It usually grows 12 or 14 feet high. Its pink flowers, of five petals, are in pairs.

The chief uses of almonds are in confectionary and pastry. They should be well chewed, since every piece is indigestible. They yield a considerable proportion, sometimes nearly half their weight, of oil by pressure. *Milk of almonds* consists of pounded almonds, loaf-sugar, and water. *Bitter* almonds resemble sweet almonds in appearance and in the trees. They yield a large portion of sweet oil, but the pulp after pressure is intensely bitter. To many animals and birds, they are a fatal poison. They are used in ratifia, and in making cherry-brandy. The oil and emulsions are used in medicine, and soap for washing the hands is made from them and sweet almonds. By confectioners, they are employed to give flavor. The principle which gives it to kernels, and also to the leaves, is *the prussic acid*, a powerful poison, and this renders a large draught of noyau, or other similar cordial, often injurious, or fatal.

*Blanched almonds* are almonds steeped in boiling water till the skin comes off by pressing between the fingers. The hot water is then strained away, and the almonds in cold water are peeled, and dried till they are brittle.—*Burnt almonds* are used to colour and flavour liqueurs.—*Bitter almonds* are a variety from Mogadore, and used to relieve the flavour of the sweet, but to clear muddy water.—*Almond cake* is left on expressing oil, and used for washing the hands.

650 tons of almonds are consumed annually in the British Islands, brought chiefly from the Barbary Coast, and Spain.

The skins of both kinds of almonds are bitter, but it rubs off by putting them in boiling water. The sweet almond in 100 parts contains 54 parts of fixed oil, and 24 of albumen, not of easy digestion. The bitter contains less oil and albumen than the sweet, but superadds volatile oil containing hydrocyanic or prussic acid. The fruit poisons some animals, and its distilled water is highly destructive, small quantities paralysing the entire nervous system. After the useful fixed oil is expressed, the cake distilled yields a very small quantity of volatile or essential oil, from which prussic acid, as a cyanuret, is obtained.

ALMOND BLOOM, a cosmetic, is made by boiling 1 oz. of Brazil dust in 3 pints of water; strain and add 6 dr. of isinglass, 2 oz. of grana sylvestria, alum 1 oz. and borax 3 dr. Boil again, and strain through fine cloth.

ALMOND OIL is obtained from ripe almonds, by simple pressure. 5·5 lbs. yielding 1·4 lbs. of oil by cold pressure, and 2 lbs. when heated. The oil of the bitter is as tasteless as that of the sweet, the bitter principle remaining in the cake, but it is poisonous to some birds and animals, and infused in cordials dangerous to man as well as other bitter kernels, when detached from their oily and farinaceous matter. By trituration, sweet almonds make a rich creamy emulsion.

Almond Oil Soap is made by macerating oil of almonds with thrice its quantity of lixivium of soap till when cold it is a jelly. Add common salt, and resume the boiling till it is solid. Skim off the water and cast it in moulds. Or it may be made simply by rubbing together in a mortar 4 lbs. of oil of almonds with 2 lbs. of barilla or kelp ley, such that an 8-oz. bottle of water will hold 11 of the ley. Put it in tin moulds, to stand for a month.

Almond Paste is divided into three kinds, namely, brown almond paste, white sweet almond paste, and white bitter almond paste; but all of them are prepared nearly in a similar way.

The first is made of the kernels taken out of apricot stones, as also with almonds; these are formed into loaves, weighing five or six pounds each, and are then subjected to pressure, in order to extract the oil (300 lbs. of kernels will yield about 130 of oil.) The press is turned or squeezed closer every two hours, during three days; at the end of this time the loaves are withdrawn from the press, when they are dried, in order to be pounded; and, lastly, are passed through a sieve.

The second kind is obtained by scalding the sweet almonds in boiling water, until their skins become completely detached; they are then put into a basket and cooled, and the skins entirely separated; when they are become dry, they are subjected to the same processes as the preceding.

The third kind is prepared as the second is, only that bitter almonds are made use of.

Almond Paste for orgeat. In water boil two pounds of almonds till the skin readily separates. In water steep these with equal weight of Italian melon-seed six hours, strain off most of the water, reduce to a fine paste, and add $1\frac{1}{2}$ pounds of sugar to each pound of paste. Dry well in a stove.

ALMS' HOUSES, are admirable institutions for virtuous old age, or incapacity from disease. Every county in England contains some, built and endowed by benevolent persons, but too often abused by unprincipled trustees. Others ought to be erected in every parish in every civilized country, as public provisions for virtuous poverty and the old age of a well-spent life. The *work*-house should be appropriated only to the vicious and profligate. Till this act of justice is conceded to poverty, discontent will prevail among the poor and labouring classes.

ALOES constitute an extensive variety of plants, from a few inches to 30 feet high. The leaves are fleshy, thick, and spinous at the edges. They are natives of hot climates. To the inhabitants they form an impenetrable fence, and the negroes of the western coast of Africa and Jamaica make ropes, nets, &c. of the fibrous parts. A Mexican aloe serves for hedges, its trunk for beams, and its leaves for tiles. It also supplies thread, needles, clothing, and cordage, and its juices wine, sugar, and vinegar. It is sometimes adopted as a preservative of ships' bottoms against worms, and an ounce mixed with turpentine, tallow, and white lead, is sufficient to protect two feet of plank. In the East Indies, the juice is used as varnish to preserve wood, skins, &c. from all attacks of insects. The inspissated juice of several species of aloes is highly valuable in medicine as a cathartic. A fine violet is afforded by the leaves of the socotrine aloe, which requires no mordant, and it is beautiful in miniature painting.

The American aloe (*agave Americana*) is a common plant in English gardens, and the period of flowering depends on the rapidity of growth. In the Tropics it flowers in a few years; but in cold ones less frequently. The stem at that time rises above the centre of the leaves to the height of 20 feet, and has been 40 feet. It forms a pyramid of flowers in thick clusters. They are sometimes set as fences in Spain and Portugal, and the leaves are employed to scour pewter utensils and floors, and in feeding cattle. The juices, made into cakes, may be used for washing, and lather even with salt-water, a valuable property. The fibres are applied to all the purposes of thread, but they are not durable.

300,000 lbs. of Aloes were imported in four years from the Cape of Good Hope, chiefly, as is believed, for the use of brewers, in place of hops; quassia and wormwood being also in use.

To procure *Socotrina* Aloes, make an incision in the leaf of the plant, collect the juice and harden it in the sun; to make *hepatica*, press the leaves and dry the product; and to make *caballina* or horse aloes, pulverize them, and add the refuse of the two former.

*Compound Decoction of Aloes*, a valuable medicine for costiveness, dyspepsia, jaundice, &c. in the dose of half to two fluid ounces, is made by boiling to three-fourths 1 oz. of liquorice, 4 scruples of subcarbonate of soda, 2 drachms each of powdered spiked aloes, myrrh, and saffron, and a quart of distilled water. Strain and add 8 fluid oz. of tincture of cardamoms.

The ALOES PILL, for habitual costiveness, is formed by Aloes 2 parts, extract of gentian 1, and some oil of carraway. 1 or 2 pills, weighing from 10 gr. or a scruple, is a dose.

Or, per Gray, evaporate to a proper consistence 4 ounces of socotrine aloes and add 1 pound of damask rose-juice.

The ALOES and ASSAFŒTIDA PILL, for costiveness and flatulency, is made of equal parts of aloes, assafœtida, and soap. 1 pill of 10 grs. is a dose.

The ALOES and MYRRH PILL, for costiveness and indigestion, should consist of aloes 2, saffron and myrrh 1.

To make *Tincture of Aloes*, digest for 7 days half an ounce of powdered socotrine aloes, 1½ oz. of dissolved liquorice, and 8 fluid ounces of proof spirit, and then strain.

To make *Compound Tincture of Aloes*, macerate for 14 days 3 oz. each of extract of spiked aloes and saffron, with 2 pints of tincture of myrrh. Then strain.

ALTITUDE, denotes the perpendicular height of the vertex of any plane, or solid body, above the line or plane of its base; thus the altitude of a triangle is measured by a perpendicular let fall from any one of its angles upon the base, or upon the base produced. Again, the altitude of a cone or pyramid, whether right or oblique, is measured by a perpendicular let fall from the vertex to the plane of its base. Similar remarks apply to other solids.—In Astronomy, altitudes are measured or estimated by the angles subtended between the object and the plane of the horizon; and this altitude may be either *true* or *apparent*. The *apparent* altitude is that which is obtained in reference to the visible horizon; and the *true* altitude results from correcting the apparent altitude, by making allowance for parallax, refraction, &c. The altitude of a terrestrial object is the height of its vertex above some horizontal plane assumed as a base. The altitude of mountains is measured, generally, from the level of the nearest ocean. If the altitude of a mountain is given without any explanation, the altitude above the ocean is always understood. This altitude can be measured trigonometrically, by barometrical observations, or by actually measuring the level between the base and vertex of an object; and, if very great accuracy is not required, by optical reflection, by the length of shadows, moveable staves, the geometrical square, &c.; and, generally, by any method in which the calculation depends upon the similarity of plane rectilinear triangles.

The greatest terrestrial altitudes are those of the Himalayas and Andes, from 25 to 22,000 feet. The highest buildings are from 5 to 600 feet above the ground. The clouds vary from 1500 feet to 30,000. The greatest height ever attained by men in a balloon has been about 25,000 feet, without experiencing inconvenience.

ALTITUDES BY BAROMETER. Take the heighth at the bottom and top of the hill, and subtract their logarithms from each other. Multiply this difference by 10,000, and the product is the heighth in fathoms, at a temperature of 31°. But, as the temperature affects the elasticity, and every degree is $\frac{1}{435}$th, so we must ascertain the mean temperature, and add or subtract as many 435ths as the temperature is more or less than 31°. Some modifications of the arithmetical mean temperature are to be made when great accuracy is required.

ALTITUDES are also easily determined by 2 poles fixed so as to see the top in line over both, for this gives the angle, and another angle nearer or more distant, the distances being measured, are data for the heighth by projection, or calculation. Or, a common quadrant gives these angles. One angle and the distance; or, 2 angles and the intermediate distance are necessary.

ALUMINUM, is a metal of which alumina, made from alum, a constituent of clay, is the oxide, just as potash is the oxide of potassium. To make this metal, by reducing the oxide, in a porcelain tube heat alumina with charcoal to redness, and pass chlorine gas over it. Mix the chloride of alumina with potassium, in a close platinum vessel, and expose them to great heat. The chlorine converts the potassium into potash, and this, with aluminum, remain in the crucible. It resembles platinum, but is as brilliant as tin. At a red heat, it is reconverted into a button of alumina of extreme hardness. When hot, dilute sulphuric or muriatic acids; dissolve it.

ALUM. Common alum is a triple salt, consisting of sulphuric acid, alumine, potash and water, or of sulphate of alumine and sulphate of potash, united together, with a certain quantity of water of crystallization. It crystallizes in regular octahedrons, which are generally truncated on their edges and solid angles. Alum may also be formed by substituting either soda, ammonia, or magnesia for the potash, without at all altering its crystalline form or its taste. It dissolves in five parts of water, at 60°, and the solution reddens vegetable blues, indicating the excess of acid which this salt contains. Exposed to heat, it undergoes a watery fusion, and becomes light and spongy, in which condition it possesses slightly corrosive properties, and is used as a caustic, under the name of *alumen exsiccatum*.

The simplest process by which alum is prepared is, perhaps, that adopted at the Solfatara near Naples, which is covered with a white clayey soil, through which sulphureous vapours are constantly emitted. This soil is always hot, and nothing more is requisite than to immerse it into cisterns, and subject the earthy matter to lixiviation; after which, the saline solution is evaporated by means of the subterranean heat, also, and placed in a situation to cool, when the alum is deposited in crystals. As nothing is added during the process, it is obvious that the alum must exist ready formed in the soil. From the presence of a small portion of iron, the Solfatara alum is not so valuable, for many purposes, as that produced elsewhere; and, accordingly, its use is mostly confined to the Neapolitan states.

The manufacture of alum directly from its component parts has, of late years, furnished a large proportion of this substance found in commerce. The process is conducted in the following manner: Sulphur and nitrate of potash (nitre) are mixed together, in the proportions for forming sulphuric acid, and brought into combustion in large leaden chambers, or rooms lined with a thick coating of plaster. The sulphur is thus acidified, and converted into vapour, and, the floor of the apartment being covered with clay of the purest kind, previously calcined, the acid gradually combines with it, and forms sulphate of alumine, which, after a few days, is dissolved out and considerably reduced by evaporation, when a solution of sulphate of potash (being the residue of the combustion of the nitre and sulphur) is poured in, and the perfect crystals of alum are deposited.

The importance of alum, in the arts, is very great, and its annual consumption is immense. It is employed to increase the hardness of tallow, to remove greasiness from printers' cushions and blocks in calico manufactories, and to render turbid waters limpid.

In dyeing, it is used to cleanse and open the pores on the surface of the substance to be dyed, and, by the affinity of the colouring matter for the alumine it contains, to render it fit for receiving the colouring particles. Wood and paper are dipped into a solution of it, to render them less combustible.

Paper impregnated with alum is useful in whitening silver, and in silvering brass without heat.

It is also largely used in the composition of crayons, in tannery, as well as by bakers to separate and whiten loaves.

Alum is a valuable astringent in medicine, and used internally to correct all kinds of discharges.

Native alum is found in most countries, in the state of an efflorescence or mould, upon the surface of certain slate clays and lavas, and, in the United States, in mica-slate rocks; also, in delicate hair-shaped fibres, occupying clefts in a bituminous shale, principally found in Italy. It may always be easily recognised by its sweetish, astringent taste, in which it resembles the artificial alum. It exists only in very limited quantities, and contains too many impurities to be of any practical use.—A native alum has of late been found near the foot of the Andes, in South America, in which soda is substituted for potash.

Crystals of alum cannot be obtained by dissolving alumina in sulphuric acid, and evaporating the solutions, the crystals being soft, and different from alum crystals, but when a solution of potash or ammonia is dropt into the liquid, it immediately deposits perfect crystals of alum.

Alum consists of:—

| | |
|---|---|
| Sulphate of alumina .. | 36·85 |
| Sulphate of potash .. | 18·15 |
| Water .. .. .. .. .. .. .. | 45·00 |
| | 100·00 |

Then, as sulphate of potash is composed of one atom of sulphuric acid, united with one of potash; and sulphate of alumina of one of sulphuric acid, and one of alumina; the relative weights of an integrant particle of each of these salts is:

| | |
|---|---|
| Sulphate of potash .. | 11·000 |
| Sulphate of alumina .. | 7·136 |
| Water .. .. .. .. .. .. .. | 1·132 |

And their relative quantities in alum:

| | |
|---|---|
| Sulphate of potash .. | 1 |
| Sulphate of alumina .. | 5 |
| Water .. .. .. .. .. .. .. | 34 |
| | 40 |

Various minerals are employed in the manufacture of alum; as, *alum stone, alum slate, bituminous shale, or common clay.*

*To make alum from alum stone.* The process at Tolfa is to moisten the stone with water for two months, till it falls to powder, and yields alum by simple lixiviation. By manufacturers, alum stone is broken into small pieces, and piled on a perforated dome, in which a wood fire is kindled. The roasted stones are then placed between trenches filled with water, and kept moist, so that it falls to powder.

The fine powder is thrown into a leaden boiler, filled two-thirds with water, and evaporated. It is then drawn off and the alum gradually crystallizes, and attaches itself to the vessel.

*To make alum from alum slate.* *Alum*

*slate* being very different in its composition, requires a different treatment. The first process is to roast the ore, and the combustion continues for a month or six weeks.

The next process is to lixiviate it with water, and it is put into reservoirs with a cock at bottom to draw off the water. The liquid is then boiled down in leaden vessels for crystallization into large wooden casks, and in a fortnight or three weeks the alum covers the sides and bottom of the cask.

*To make alum from shale and slate clay.* Alum, from bituminous shale, and slate clay, is made very like that from alum stone and alum slate.

*To make alum from clay.* Mix 100 parts of clay, 50 of nitre, and 50 of sulphuric acid (1·367,) put it into a retort, and distil it. Aquafortis rises, and the residue, after lixiviation with water, yields excellent alum.

In Germany, alum is made from a brown coal called alum earth, by similar means.

The greatest alum mine in England is at Whitby, and is of alum-slate. The stratum is about 29 miles in width, and disposed in horizontal beds; the upper part being the richest, and is five times more valuable than that which is taken 100 feet lower. The slate is burned by breaking it into small pieces, laying a bed of furze, brush wood, and cinders on the ground, and piling the slate upon it to the height of four feet. Fire is then set to the fuel, and fresh slate thrown on the pile, until the heap is raised to the height of 90 or 100 feet, and 200 feet square at bottom. If the fire grows too fierce, its rapidity is checked by throwing on the places slate broke into very small pieces and moistened. 150 tons of calcined alum slate produce a ton of alum.

The calcined slate is washed four times successively, in pits which usually contain about 60 cubic yards: the water being passed through the most exhausted slate first, and through new slate last: remaining on each for a day and a night. The ley is drawn off into cisterns to settle, and afterwards reduced in quantity by heating in large leaden boilers, set on a gentle slope, upon iron plates. The pans are filled two-thirds with the mother liquor of the crystallizing cisterns, and one-third of fresh-made ley, and evaporated, until, in the language of the manufacturers, it weighs 36 pounds.

The alum makers' weight is a statical mode of ascertaining the specific gravity of the leys. A stone ware half-pint bottle is taken and weighed. It is then filled with rain water, and weighed again, and a lead or brass counterpoise made to it. The weight of the water which it contains is divided into eighty parts, which are called indifferently penny weights, or pounds, and a pile of weights are adjusted to these denominations; so that the penny weights or pounds that a liquor is said to weigh, in the alum and copperas works, means so many eightieth parts above the specific gravity of water. The strength of the ley, above mentioned, is therefore 1·45, and at this period kelp ley, weighing two pounds, or 1·025 is added in sufficient quantity to reduce the alum ley to 27 pounds, or 1·3375. The ley is then run off into settling cisterns, and from thence to crystallizing cisterns. When the ley is very red, urine is added to reduce it, as well as kelp ley. After standing four days, the mother water is pumped off into the boilers; the alum-crystals are slightly washed, drained, and then dissolved in the smallest possible quantity of boiling water, and the ley run off into large casks, where it remains for a fortnight. The casks are then taken to pieces, and the roach alum is found in a solid mass, with a cavity in the centre.

ALUM WATER, (Bates) mix alum and white vitriol, each half an oz. with water 3 lbs. and filter. It is a fine astringent for ulcers and eruptions, also for gonorrhea and fluor albus.

*Beaume's* ALUM, is Roman alum 1 lb. honey half a lb; dried, powdered, and calcined in a shallow dish to whiteness, then wash and dry, and it is a beautiful white, even with oil.

*Compound solution of* ALUM, a powerful astringent, is made by boiling an oz. of alum and of sulphate of zinc in two quarts of water, and filtering.

*Dry alum, and burnt* ALUM, are preparations made in vessels with moderate heat, till boiling ceases. It destroys the fungus of old ulcers, and it allays cholic.

*Magistery of* ALUM, *or Earth of alum, or Pure alumine*, (Gray) is made by dissolving alum in water, and adding to the solution sufficient ammonia water to precipitate the earth. It is then washed well, and dried; or, take dry ammoniacal alum, rub it to powder, and keep it red-hot in a crucible for some hours.

*Soda* ALUM, or sulphate of alumine, may also be crystallized, by adding soda, or soda salts, to the ley of alum slate. It cannot be distinguished in appearance from the common alums, and if pure undergoes no alteration by exposure to the air; when impure it is easily crushed between the fingers, and its surface soon becomes powdery in the air. 100 parts of water dissolve no less than 327 of soda alum, so that it is far more convenient to dyers and calico-printers.

ALUM SLATE; a slaty rock, of different degrees of hardness; colour grayish, bluish, or iron-black, and often possessed of a glossy or shining lustre.

It is chiefly composed of silex and alumine, with variable proportions of sulphuret of iron (iron pyrites), lime, bitumen, and magnesia. It is found abundantly in most European countries, and from it is obtained the largest part of the alum of commerce. As the alum-slate contains only the remote principles of this salt, the process for obtaining it is somewhat complicated. In the first place, it is requisite to acidify the sulphur of the pyrites, and combine it with the alumine. This is effected by roasting the ore in contact with the air, and then lixiviating it; after which, potash is added, and the crystallized alum obtained by evaporation.

ALUM STONE; a mineral of a grayish or yellowish-white colour, fine-grained, and approaching to earthy in its composition, and filled with numerous small cavities. It may be scratched with the knife, and easily reduced to fragments. Strongly heated, it emits a sulphureous gas. It is composed of alumine, 43·92; silex, 24·; sulphuric acid 25·; potash, 3·08; water, 4. It is found at Tolfa, in Italy, in secondary rocks.

ALUMINA; one of the earths entering most largely into the combination of all rocks, clays, and loams. From its forming the plastic principle in clays, it was formerly called *argil*, or the *argillaceous earth*; but since it has been ascertained that it constitutes the base of the salt alum, it is styled *alumine*. Like the other earths, it was regarded as an elementary substance in chemistry, until the researches of Davy led to the belief that it was a compound of a peculiar metallic base with oxygen.

It exists in the state of a hydrate that is in combination with water, and nearly pure in the corundum gems. The porcelain clays and kaolins contain about half their weight of this earth, to which they owe their most valuable properties. Alumine may be obtained pure by adding, in the first place, to a solution of alum in 20 parts of water, a small quantity of a solution of carbonate of soda, to precipitate any iron that may be present, and afterwards a little water of ammonia (*aqua ammoniæ*) to the supernatant liquid, separated from its precipitate, which, uniting with the sulphuric acid of the alum, liberates the alumine. On being washed and thoroughly dried, it is of a white colour, and without taste or smell. It is soluble in liquid soda and potash, from which it may be separated, unaltered, by the acids. It is infusible, except in the heat of the compound blow-pipe. Alumine is the basis of porcelain pottery, bricks, and crucibles.

It has a strong affinity for oil and coloring matter, which causes it to be employed, in the state of clays, as a cleansing powder, and, in a state of purity, in the preparation of lakes, in dyeing and calico-printing.

It combines with the acids and forms numerous salts; the most important of which are the sulphate of alumine and potash, and the acetate of alumine. This salt is formed by digesting srtrong acetic acid (vinegar) upon the newly-precipitated earth; but, for the use of the manufacturer, by decomposing alum with acetate of lead (sugar of lead,) or, more economically, with acetate of lime, a gallon of which, of the specific gravity 1·050, is employed for every $2\frac{3}{4}$ lbs. of alum. The sulphate of lime formed then falls to the bottom, and the acetate of alumine remains in solution with an access of alum, which is necessary to prevent its decomposition.

It is of extensive use in calico-printing and dyeing, as a mordant, and is employed in the place of alum, to which it is generally preferred. Its equivalent is 26.

Alumine, acetate of, is prepared in large quantities for calico-printers, generally by pouring a solution of 70 pounds in potash alum into a solution of 100 pounds of sugar of lead, and decanting off the liquid portion; or it is sometimes prepared for inferior work, by adding a saturated solution of quicklime in pyroligneous acid, so diluted with water as to have the specific gravity of about 1·05 to a solution of alum, in the proportion of four gallons of the acetate of lime-water to each 11 pounds of alum employed; and separating the sulphate of lime that falls down, by straining off the liquor. Acetate of alumine is employed instead of alum, as a preferable preparative in dyeing and calico-printing.

Alumine, hydrate of, is pure alumine, not dried, but in a moist state used to mix with oxide of cobalt and other colouring oxides as a basis for the colour.

AMBER, a well-known mineral substance, is brittle and yields easily to the knife. Specific gravity, 1·081. It burns with a yellow flame, emitting a pungent, aromatic smoke, and leaving a light, carbonaceous residue, which is employed as the basis of the finest black varnishes. By friction it becomes strongly electric; from which property originated the name and science of electricity. With this substance Thales, one of the Greek philosophers, performed the first electrical experiment.

It is found in masses, from the size, of coarse sand to that of a man's head, and occurs in beds of bituminous wood situated upon the shores of the Baltic and Adriatic seas; also in Poland, France, Italy, and Denmark. Recently it has been found in the United States, at Cape Sable, in Maryland.

From its occurring very frequently attached to pieces of bitumenized wood, and containing insects, it is inferred, with great probability, that amber originated from vegetable juices, and has undergone its present modification, possibly, from sulphuric acid, derived from the iron pyrites which always abound in the deposits where it occurs.

It is susceptible of a good polish, and has, at different times, been much esteemed as a personal ornament; but its want of hardness and lustre, together with the ease with which imitations are made of it, have brought it into comparative disuse.

By distillation it affords an oil, and a peculiar acid, the former of which is denominated *oil of amber*, and the latter *succinic acid*, from *succinum*, the Latin name for amber. The succinic acid, when purified, exists in white, transparent, prismatic crystals. It is soluble in water and alcohol; has strong acid properties; it forms salts with the alkalies and several of the earths. The succinate of potash is useful in analysis for the separation of oxyde of iron. Oil of Amber is distilled from coarse, useless pieces, and useful in palsy, hooping-coughs, rheumatism, &c.

Polangen, the frontier sea-port of Russia, is famous, says Granville, for its trade in amber. This substance is found by the inhabitants on the coast, between Polangen and Pillau, either loosely on the shore, on which it has been thrown by the strong north and westerly winds, or in small hillocks of sand near the sea, where it is found in regular strata. The quantity found yearly in this manner, and on this small extent of coast, besides what little is sometimes discovered in beds of pitcoal in the interior of the country, is said to amount to from 150 to 200 tons. As amber is much less in vogue in Western Europe than in former times, the best pieces, which are very transparent, and frequently weigh as much as three ounces, are sent to Turkey and Persia, for the heads of hookahs. Very few trinkets are now sold for ornaments to ladies' dresses; and the great bulk of amber annually found is converted into scented spirits and oil, for the composition of delicate varnish. In the rough state, amber is sold by the ton, and forms an object of export trade from Memel and Konigsberg.

Amber Varnish. Melt 8 oz. of scio-turpentine, add 1 lb. of powdered amber, macerate for half an hour, and add 2 oz. of warm white rosin, and 1 lb. of hot linseed-oil. When cold, strain it.

AMBERGRIS, is a substance found floating in the sea near the coasts of various tropical countries, and has also been taken from the intestines of the spermaceti whale, where it is supposed to originate, owing to disease.

It is met with in masses of various sizes, sometimes weighing nearly 200 pounds. Its colour is a yellowish or blackish white; it is generally brittle, and may be compressed with the teeth or nails. Its odour is very agreeable, and hence arises its only use.

In the state of an alcoholic solution, it is added to lavender-water, tooth-powder, hair-powder, wash-balls, &c. to which it communicates fragrance.

Ambergris has little odour without the addition of musk, and so with lavenders. Musk, and other scented bodies, are exposed in privies, where the ammonia restores their odour. In truth, odours are excited or destroyed by other bodies. The odour of snuff is destroyed by tartaric acid. Oil of mustard loses its odour in contact with metal and becomes a sulphuret, while acid improves the odour of mustard. Iron has little odour till volatilized with hydrogen.

AMIANTHUS DRESS FOR FIREMEN. The method of preparing *amianthus*, for the purpose of making incombustible cloth, is thus stated in an Italian journal. The amianthus is exposed to the action of steam, in a vessel made for the purpose, and which will hold more than 3,000 pounds of the mineral, so that all parts of it may be acted on by the steam. The fibres, by this action, become loosened, and acquire so much flexibility that they are easily separated, so as to obtain thread as fine as silk, and of several diameters about four inches in length. A fireman with the double protection of incombustible cloth and wire-gauze, subjected his face to the flame of a straw-fire held in a chafing-dish, for the space of a minute and a half.—Another, with the addition of a sheet of amianthus in front, supported the heat during two minutes and a half, without any symptoms of suffering. Two parallel hedges, about three feet distant from each other, were formed of straw and brushwood, piled upon bars of iron. When these were set on fire, the flames from the two rose in a body to the height of at least nine feet, and filled the entire space between; while the heat was too great to approach nearer than eight or ten paces. At this instant six firemen, accoutred with the dress of M. Aldini, and following each other at a slow pace, traversed the flames between the hedges many times in succession. One of them carried an osier basket covered with wire-gauze, containing a child eight years old, protected only with a mask of incombustible cloth.

London fire-men pass through rooms on fire by crawling with their faces close to the floors, where there is a current of pure air. But amianthus dresses would be a great advantage.

**AMMONIA**; an alkaline substance, differing from the other alkalies by its volatility, not being obtained pure, except in gaseous form, and hence called *volatile alkali*.

It is obtained by mixing together equal weights of dry quick-lime and muriate of ammonia (sal ammoniac), separately powdered, and introducing them into a retort or iron bottle, and applying heat. It is a transparent, colorless gas, of little more than half the weight of common air, and has an exceedingly pungent smell, well known under the old name of spirits of hartshorn. It extinguishes flame, and is fatal to life. It is decomposable, by a strong heat, into 3 parts, by measure, of *hydrogen*, and 1 of *nitrogen* gas.

It is rapidly absorbed by water, which dissolves one-third of its weight of this gas, or 460 times its bulk, and forms the aqueous ammonia, or *aqua ammoniæ*. The process for procuring this is merely to connect a retort, or iron bottle, containing the muriate of ammonia and quick-lime (generally slacked,) with a common still and refrigeratory, and apply a moderate heat. It is very accurately valued by its specific gravity; that used in medicine is about 0·950. It is also soluble in alchol, and is used in medicine under the name of spirits of hartshorn.

Ammonia combines with the acids, and forms a numerous class of salts: with carbonic acid, it forms the carbonate of ammonia (volatile sal ammoniac,) which was formerly prepared from the destructive distillation of animal substances, but is now fabricated, in part, by mixing one proportion of muriate of ammonia with two of carbonate of lime, in a state of dryness, and subliming in an earthern pot; and, more largely, from purified sulphate of ammonia, mixed with one quarter of its weight of chalk, finely ground, and previously calcined, introduced into cast-iron retorts, and subjected to a red heat. The carbonate of ammonia, as it is formed, is conveyed by a tube into a leaden or cast-iron receiver, where it is condensed. It is used as a stimulant, usually in the form of smelling-bottles, and also by bakers, to raise their bread lighter and quicker than by yeast alone.

With muriatic acid, ammonia forms muriate of ammonia (sal ammoniac.) It is found native in fibrous masses and crusts, sublimed into the cracks of lava, among other volcanic matters, about the craters of volcanoes. The muriate of ammonia of commerce, however, is prepared, by a tedious process, from an impure carbonate of ammonia, obtained by the distillation of bones and other animal matters: the carbonate is decomposed by sulphate of lime, and the sulphate of ammonia again by muriate of soda; and the muriate of ammonia is separated from the sulphate of soda by crystallization, after which it undergoes the process of sublimation two or three times; and, this being done in rounded vessels, it assumes the form with which we are familiar with it.

The sulphate of ammonia, obtained in procuring gas-lights for illumination from coal, is also made use of in the manufacture of sal ammoniac. It has lately been discovered, that muriate of ammonia exists in the water of the ocean, and, that it may be obtained, by sublimation, from the uncrystallizable part called *bittern*.

Ammonia was formerly imported from Egypt, but is now manufactured in Europe. Great quantities are annually carried from Bucharian Tartary to Russia and Siberia.

Salts of ammonia are 77 in number, and there are also 68 double salts containing ammonia.

Sal ammoniac is applied to many useful purposes. Occasionally, it is used in medicine.

A considerable portion of it is consumed by dyers, to give brightness to some of their colours.

It is also employed in the assay of metals, to discover the presence of iron; and, having the property of rendering lead brittle, is sometimes used in the manufacture of shot.

By coppersmiths and tinners, it is used for cleansing the surface of the metals which they are about to cover with tin. 20 tons of sal ammoniac, for the purpose of soldering, are annually used in Birmingham.

It is much combined with animal, and in their excrements, which is the cause of the offensive odour. It is supposed to arise from the absorption of nitrogen at the skin and the food.

Ammonia, a compound of nitrogen and hydrogen, and almost a solitary example of the combination of these elements, consists of 1 nitrogen (14,) and 3 hydrogen (3) = 17 as the chemical equivalent. It forms salts with acetic acid, (called spirit of mindererus) with carbonic acid, with citric acid, with chlorine and sulphuric acid. It is prepared from sal ammoniac native, or a sublimation from soot, and in Egypt is made from the soot of camels' dung.

In making Ammonia from bones, &c. they are broken small and boiled, and then distilled in iron cylinders. Impure alkali and offensive oil are the products, and the former, by various conversion and purification, is converted into cakes of ammonia. Gas-works, and the use of soot, however, are superceding this practice. When the specific gravity is 0·905, the ammonia is 25·37, and water 74·63; and when 0·9513, they are 12·4 and 87·6.

To make *Acetate of Ammonia*, pour gradually as much acetic acid on powdered carbonate of ammonia as saturates it.

*Aromatic Spirit of Ammonia* is made by macerating for three days, in a close vessel, a quart of spirit of ammonia, 2 drs. of oil of lemons, 3 drs. of cinnamon bark, and half an ounce of bruised nutmeg, and then distilling $1\frac{1}{2}$ lb. Or, take subcarbonate of potash and *sal ammoniac*, each 6 oz., adding leaves of marum syriacum half an oz., alcohol half a pint, impregnated with oil of caryophyllus half a dram, oil of cinnamon 1 scruple, oil of nux moschata, oil of marjoranæ, lemon, and aurantium, each 1 dram, water 2 pints; the whole being distilled with very gentle heat, and as soon as the rising liquid begins to dissolve the salt that has sublimed, take the vessel from the sand.—*Gray.*

To make *Carbonate of Ammonia*, rub 400 grains of white marble to fine powder, and also 300 grains of muriate of ammonia, and mix them. Sublime them by a sand bath, or lamp in a florence flask, and pass its neck into a cool receiver. Or, 2, it is made by mixing, 1, sal ammoniac with, 2, powdered chalk and subliming. Or, 3, it is made by mixing equal parts of sal ammoniac and subcarbonate of soda and subliming.

To make *Sub-carbonate of Ammonia;* pulverize two lbs. of muriate of ammonia, or sal ammoniac, and, also, 3 pounds of prepared chalk. Sublime the mixture with a heat increased to redness. It is the common smelling salts, and given internally is stimulant, antispasmodic, and anti-acidulous. 1 pulverized with more, with 3 balladoner, is a plaster for rheumatism.

The *Bicarbonate* is a solution of carbonate exposed to the action of carbonic gas, raised by muriatic gas acting on marble.

To make *Ammoniacal Gas*, mix well equal parts of muriate of ammonia and quick-lime, put it into a retort over a spirit lamp, and receive the gas in jars over mercury. The muriatic acid gas absorbs an equal volume, and the two form solid muriate of ammonia.

The *Hydro-sulphuret of Ammonia*, or sulphuret of iron, is employed medically to correct the morbid appetite in diabetes, and is made by mixing 4 oz. of muriatic acid on 16 of water, pouring them on 2 oz. of sulphuret of iron, and passing the gas through 2 oz. of water of ammonia. Keep closely stopt.

*Nitrate of Ammonia*, or inflammable nitre, the base of intoxicating gas, is made by saturating dilute nitric acid with sub or sesqui carbonate of ammonia, evaporating and crystallizing. It is 1 ammonia (17,) 1 nitric acid (72,) and 2 or more water.

The *Sulphate of Ammonia* is obtained in the proportion of 1 lb. per gall. from the liquor which results from distilling coals. A ton yields about 20 gallons. It is tested by various weights of calcined gypsum and litmus paper in different small vessels, and calcined gypsum added to the mass. Every gallon requires about 1 lb. of sulphuric acid, and when stirred together it is wholly evaporated by boiling. The sulphate of lime which falls must be removed, and the crystals of sulphate of ammonia be taken out as they form, and drained. The crystals are, 1 sulphur, 1 ammonia, 1 water, and are used in making sal ammoniac.

*Smelling Salts* are another ammoniacal preparation, consisting of a sublimation at a gentle heat of 8 oz. of subcarbonate of ammonia, and an ounce and a half of oil of lavender.

*Sulphate of Ammonia*, in the form of stalactites, is found in the fissures of the earth surrounding certain small lakes in Tuscany; also in the lavas of Ætna and Vesuvius, and dissolved in a spring, in Dauphine.

*Sal Volatile* drops are made of 30 oz of volatile sal ammoniac, 3 gallons f raw spirits of wine, and three oz. of mixed oils (to be made separately) of essence of bergamot, essence of lemon 1 oz. each, and of oil of lavender and oil of pimento each half an oz.—*Gray.*

*Spirit of Ammonia*, or sal volatile, is made of 3 pints of spirit, $3\frac{1}{2}$ oz. of powdered carbonate of ammonia, dissolved at a moderate heat, and filtered.

The *Spirit of Hartshorn* and the salt of hartshorn owe their volatile qualities to ammonia. The first is obtained by distillation from hartshorn, &c. and rectification. The latter is purified by mixture of an eighth chalk, and subsequent sublimation at a gentle heat.

*Ammonia Water* is made by slacking a lb. of quick-lime in nearly 3 pints of water, and in an hour adding a boiling solution of 1 lb. of sal ammoniac in 3 quarts of water. Cover close, and strain when cold. Then distill 24 oz. measure into a receiver kept in water at 50°.

AMMONIAC, SAL, *or Muriate of Ammonia*, is made by decomposing salt with sulphuric acid, in a reverberatory furnace, and by the muriatic acid gas passing into a leaden chamber it is mingled with the vapour of carbonate of ammonia, distilled from animal substances in cylindrical retorts. The two gases condense into sal ammoniac or muriate of ammonia.

The process to make *Sal ammoniac*, of Beaumé, was to distil animal substances so as to procure carbonate of ammonia, and with this salt he decomposed the muriate of magnesia as it exists in the ley of salt made from sea-water. The liquid was then evaporated, and the sal ammoniac sublimed.

*Another method* is, to bring into contact, in a leaden chamber, vapours of ammonia, procured by distilling animal substances, and of muriatic acid, obtained by decomposing common salt with sulphuric acid. Davy procured sal ammoniac chiefly from soot, and converted it into sulphate of ammonia with sulphuric acid. The sulphate was then mixed with salt, and thereby Glauber's salt was obtained by crystallizaton, and Sal Ammoniac by sublimation.

Others extract it from bones, woollen rags, and other animal substances. These are bruised and boiled, and the fatty part used for soap. The other part is put into iron cylinders and made red-hot. From one end an iron pipe of twenty feet terminated in a leaden receiver cooled by water. At the remote end is a pipe and plug to draw off the condensed liquor, and a hole for the uncondensible vapour to pass off. A charge of a cylinder yields about 36 lbs. of the alkaline fluid, and 30 lbs. of black oil, which being skimmed off, the alkali is saturated with sulphuric acid, which unites with the ammonia, while the carbonic acid combines with the gypsum. Mixed with salt, Glauber's salt and sal ammoniac are formed. To separate them the liquid is allowed to subside, and is then transferred into oblong leaden boilers, heated so as to evaporate. The Glauber's salt crystallizes, and is swept off into baskets placed over the boiler. When feathered crystals of sal ammoniac begin to appear, the liquid is run into coolers, and it there deposits sal ammoniac till it sinks to 70°. The salt while hot is now put into earthen jars, with covers, and a hole in the centre, luted with clay and horse-dung, and these are set in earthen pots over a strong fire in a furnace, at a temperature of 320°, and finally raised to strong red heat. The aqueous vapour escapes through the hole in the cover. The hole must be left open as long as moisture exhales, but when the water is gone the hole is to be stopped up with lute. The sal ammoniac sublimes, but if the heat is continued too long, the cake becomes yellow, scorched, and crackled.

Sal ammoniac, is largely used by bakers when bread is hurried. By this mixture it may be baked as soon as the dough is mixed. It gives it a yellowish cast, and the cells are very small.

AMMONIAC, WHITE SAL, is made by adding oil of vitriol to bone spirit, crystallizing the product, and mixing it with common salt, then subliming. The residuum, dissolved in water and crystallized, is Glauber's salt.

AMMONIACUM, is a gum resin of Barbary and India, and used with rhubarb in expelling the mucus which generates colic, also in asthma, catarrhs, &c.

AMPUTATION, in surgery, is that operation by which a member is separated from the body according to the rules of the science. It may be considered as one of the great victories which science and skill have gained over barbarism. There is no decisive proof that Hippocrates ever performed this operation. But Celsus, who lived under Tiberius, has left a short description, in his book *De Re Medica*, of the mode of amputating gangrenous limbs. The Arabians made little progress in the art of suppressing the bleeding after the amputation, which was still the most important desideratum. The greatest improvements were introduced by Pari, a French surgeon, in the 16th century, since whose time amputation has been performed among all civilized nations with great precision and success.

AMYRIS GILEADENSIS, is a true indigenous in Abyssinia, but in early ages transplanted into Arabia Felix, and famous through the east for the Balm of Gilead or Mecca, produced from its resin, carried as a medicine all over central Asia, in the camel droves of the itinerant merchants. The tree itself is one of little promise, short, stunted, and crooked. The resin or balsam is procured by incision in the bark; the first flow is light yellow, and most esteemed; but the colour afterwards deepens. That which is expressed from the fruit is green, and was more prized. It is still a specific among Mahomedans for stomachic and internal complaints, but whatever be its virtues, none reaches western Europe, though the druggists vend a Canadian resin under its name, and we have a quack medicine sworn to be made from it.

ANALEPTIC PILLS. Mix 8 oz. of gum guaiacum, 8 oz. of crocus of antimony, and 1 lb. of pil. rufi, (made of 6 oz. of socotrine aloes, and 3 of myrrh, and 3 of saffron, with syrup of crocus 4 ounces.) Each dram supplies 32 pills.

ANALYSIS, CHEMICAL, is a branch of that science most important in many of the useful arts. Chemical analysis has effected great changes in the methods of elucidating the nature of all substances, the tendencies of simple substances to combine or to be affected by heat; it detects the components of compounds, and, by successive proofs, (generally original, or for the first time observed,) shews the *modus operandi* of nature's processes, and enables us to adopt beneficial imitations of them in manufactures and the arts. Therefore, while the patient diligence of the investigation is amply repaid by the mental power created, an inquiring habit is induced. There is therefore great propriety, as well as utility, in every manufacturer and artizan being intimately acquainted with such processes and modes of manipulation that whatever advantage circumstances may present, he may beneficially avail himself of them. Compound substances are, in reference to their elements, either *Binary* or *Ternary*; and, as some elements do not ever meet together in the same compound, when one such is present, its opponent will be absent, and need not be sought. And when an element is found, its proportion in the compound can be readily ascertained by calculation, since all elements combine in unvarying proportions.

The *Binary Compounds* include the earths, fixed alkalies, also ammonia, common salt, ordinary metallic oxides, alloys, acids, sulphurets, and carburets; and many substances in which are present only a base and an acid.

The *Ternary Compounds* include all the substances which have the chemical name of salts, (the *ates* and *ites*) and those in which three elements, with the few in which more than three are present, bases and acids.

The fundamental components of substances are named *bases*, *acids*, and *non-metallic* bodies; and the following are most abundant—

*Bases.*—1. Potass. 2. Soda. 3. Ammonia. 4. Barytes. 5. Strontia. 6. Lime. 7. Magnesia. 8. Alumine. 9. Protoxide of manganese. 10. Oxide of zinc. 11. Oxide of cobalt. 12. Oxide of nickel. 13. Protoxide of iron. 14. Peroxide of iron. 15. Oxide of cadmium. 16. Protoxide of lead. 17. Oxide of bismuth. 18. Deutoxide of copper. 19. Oxide of silver. 20. Protoxide of mercury. 21. Peroxide of mercury. 22. Oxide of gold. 23. Protoxide of tin. 24. Peroxide of tin. 25. Protoxide of antimony.

These very seldom:—26. Lithia. 27. Glucina. 28. Thorina. 29. Yttria. 30. Cerium. 31. Zirconia. 32. Oxide of platinum. 33. Oxide of chromium.

*Acids*, most frequent: 1. Sulphuric. 2. Nitric. 3. Phosphoric. 4. Arsenic. 5. Boracic. 6. Carbonic. And less frequent: 7. Chloric. 8. Bromic. 9. Iodic. 10. Silicic. 11. Chromic.

*Non-metallic bodies.* 12. Chlorine. 13. Fluorine. 14. Sulphur. 15. Bromine. 16. Iodine.

Compound substances may readily be wrapped in a piece of brown paper, and broken small by a hammer; then, on a slab, be rubbed fine with a muller and water. The water is to be kept, the sediment rubbed and washed, and the whole is evaporated dry, to save all the fine particles.

When proper, heat the substance in a small crucible, till it ceases to lose any weight; then, in a warm mortar, quickly mix it with four times its weight of pure carbonate of potass; again gradually heat, and keep at a red heat at least one hour. When cool, empty into a glass with water; wash the crucible with water first, and then with dilute muriatic acid. The substance is then ready for analysis.

To proceed with the greatest facility and certainty, the student should provide himself with plenty of *distilled* water, and a dozen small *test tubes*, in preference to test glasses.

The metallic oxides, the metallic acids, the alkalies, and the earths, are severally distinguished from each other by peculiar colours, and their more or less easy reduction. Certain substances *are precipitable in watery solutions* by alkaline carbonates, as Epsom salts, or sulphate of magnesia; alum, or sulphate of alumine and potass; copperas, green vitriol, or sulphate of iron; blue vitriol, or sulphate of copper; white vitriol, or sulphate of zinc; red vitriol, or sulphate of cobalt; horn mercury, or muriate of murcury; *but* the following are not so precipitable: sedative salt, native boracic acid, or sassolin; borax, borate of soda, or tincal; natron, carbonate of soda, or trona; saltpetre, nitre, or nitrate of potass; sal ammoniac, or muriate of ammonia; common salt, rock salt, or muriate of soda; fibrous rock salt, or Glauberite.

Some compound substances, composed of only one base and one acid, and others composed of two or more of both, are, in water wholly, partially, or in no degree soluble; yet are wholly soluble in muriatic or in nitric acid; and others similarly compounded are not at all soluble, either in water or acids.

1. To ascertain the Component Base and Acid.—Let a portion of the substance be pulverized very fine between paper, and its degree of solubility ascertained by introducing a small quantity into water and into muriatic and nitric acids.

1. *When the substance wholly dissolves in water*, let most of the solution be evaporated; and, to a small portion, in a test tube, drop a little muriatic acid; a *white* precipitate will indicate nitric acid to be next employed; otherwise, use muriatic acid.

(*a*) The solution must be slightly acidulated; and next add, till the solution smells strongly thereof, liquid sulphuretted hydrogen, when the continuance of the solution as before will determine the base to be one of those numbered from 1 to 13 : but *a precipitate* will determine it to be one of those numbered from 14 to 25 inclusive. And, to ascertain which, there should be a small portion of the solution put into six test tubes, to prevent mistakes.

(*b*) *When the precipitate is milk white, dark brown, or orange red*, the base is No. 14, or 23, or 25. When that is yellow, neutralize, by ammonia, the solution in the test tube; then add hydrosulphuret of ammonia, and the yellow precipitate which results will be easily soluble when that is added in excess, when the base is No. 24, but will continue insoluble when the base is 15.

(*c*) *When the precipitate is black*, and a small portion renders much water milky, the base is No. 17. When ammonia causes a deep blue tint without, precipitate insoluble in excess, the base is 18. When a few drops of muriatic acid cause a white precipitate, insoluble when much diluted, but rendered black by excess of ammonia, the base is No. 20; and the same base will, in the acidulated solution, supply a grey precipitate, insoluble in excess, on ammonia being added. But when ammonia does not cause a precipitate in the acidulated solution, the base is No. 19, which base also will, in the dilute solution, be a brown precipitate, soluble in excess of the ammonia added. When excess of solution of caustic potass causes a yellow precipitate, the base is No. 21. When solution of protosulphate of iron causes a brown metallic precipitate, the base is No. 22; and, when dilute, sulphuric acid, or solution of a sulphate, causes a white precipitate, the base is 16.

(*d*) *When the liquid sulphuretted hydrogen fails to supply a precipitate*, the acidulated solution must be neutralized by ammonia, and then must be added hydrosulphuret of ammonia; and when there results a precipitate, flesh-red, the base is No. 9. When that is white, and is soluble on adding excess of caustic ammonia, the base is No. 10; when it is insoluble therein, the base is No. 8. When the precipitate is black, but alters, on adding a solution of carbonate of potass or of soda, into bright green, the base is No. 12; into dirty red, the base is No. 14; and first white, then green, and at length brown-red, at surface, the base is No. 13.

(*e*) *When the hydrosulphuret of ammonia fails to cause a precipitate*, to the neutral solution add solution of carbonate of potash; and when a white precipitate results, add caustic ammonia, and a white flocculence will appear (unless the solution be acid,) and shew the base No. 7. The absence of a precipitate will leave the student opportunity to add a concentrated solution of caustic potass; and, when either a rod moistened with muriatic acid, or the peculiar odour is perceptible, the base is No. 3; but else there must be added alcoholic solution of chloride of platinum. When the solution remains unaltered, the base is No. 2; when it supplies a yellow precipitate, the base is No. 1.

(*f*) To the solution of the substance first made slightly acid, add hydrofluosilicic acid, and let the liquid remain undisturbed eight days. When a precipitate results, the base is No. 4; but when the base remains in solution, dilute this much, and add a little solution of sulphate of potass, or of dilute sulphuric acid; and when a precipitate immediately results, the base is No. 5; but, when some time transpires, and there results a crystalline precipitate, the base is No. 6.

2. THE ACID, OR NON-METALLIC SUBSTANCE IS ASCERTAINED AS FOLLOWS :—

(*a*) *When the solution effervesces with muriatic acid*, there will be present either carbonic acid or a sulphuret of from No. 1 to No. 25, known by the gas evolved being either inodourous or smelling of sulphuretted hydrogen.

(*b*) *When no effervescence ensues*, neutralize the solution, evaporate much, and add solution of chloride of barium; and when a white precipitate results, not altered by muriatic acid, the acid is No. 1; but when it dissolves, boil both in liquid sulphuretted hydrogen, and a yellow precipitate will ensue when the acid is No. 4, but not when it is No. 3.

(*c*) *When a platinum crucible can be employed* it is best; but when that is not available, a wedgwood capsule may be used; into which pour a little sulphuric acid, throw in some of the powdered substance, and cover with glass on which wax is laid, but scored through in various ways; gently heat, and when cool, if the glass be corroded, the compound is a fluoride. When the glass remains uncorroded, add alcohol, and inflame, and when green, the acid is No. 5.

(*d*) *When the solution of nitrate of silver causes in the other solution a white precipitate*, the substance is a chloride of the metal of one of the first 25 bases. Or, when the powder, strewed on red coals, increases their combustion and deflagration, the acid is No. 2.

3. WHEN THE COMPOUND IS ONLY PARTIALLY SOLUBLE IN WATER, BUT WHOLLY IN MURIATIC OR NITRIC ACID.

Ascertain, by the processes just mentioned, whether to employ nitric acid, because of the presence of Nos. 16, or 19, or 20, or a sulphuret; or to employ muriatic acid, occasionally with heat.

(*a*) Into a glass tube, with dilute acid, put some of the substance, and add liquid sulphuretted hydrogen; when a precipitate will indicate the base to be in No. 14 to 25, which will be determined by the processes *b* and *c*. And when arsenic acid is present, its sulphuret will precipitate by employing moderate heat for some days. The sulphurets precipitated being much affected by the sulphuretted hydrogen, they need to be quickly filtered, the liquor boiled, and the next precipitate tried by the blowpipe. When oxides precipitate, they do so quickly, and with definite colours.

(*b*) *When liquid sulphuretted hydrogen does not cause a precipitate*, with ammonia supersaturate the acidulated solution; add hydrosulphuret of ammonia, and a black precipitate will indicate the base in No. 11 to 13, which will be discriminated by the blue (11,) or red (12) or deep red (13,) tint given to borax or micaceous salt, fused with the precipitate on platinum foil with the blowpipe. A flesh-red precipitate shews the base No. 9. And a white one shews it No. 10 or No. 8, except the acid 3 or 5 be present with the bases No. 7 to 4; or these, with fluorine, thus ascertained :—

(*c*) *When the precipitate is insoluble in caustic potass and ammonia*, or is resolved in the acid solution by excess of ammonia, the base is No. 10. Also, when the compound, mixed with soda, gives a white, or moistened with solution of cobalt, gives a green, heated on charcoal by the inner flame of the blow-pipe lamp. But, when the precipitate is soluble in excess of caustic potass, the base is No. 8. Also, when the flame is blue, by the blow-pipe.

(*d*) *When the acid solution, diluted, supplies to dilute sulphuric acid a white precipitate*, to a portion in a test tube drop hydro-fluosilicic acid; and, after 12 hours, a precipitate shews the base No. 4; no precipitate, the base No. 5; unless alcohol cause a white precipitate, No. 6; but no precipitate, the base No. 7. Also, when the compound, moistened with solution of nitrate of cobalt, gives a pale red flame, heated on charcoal by the blow-pipe.

(*e*) *When sulphuretted hydrogen* (*a*) *and hydrosulphuret of ammonia* (*b*) *fail to cause a precipitate*, dilute the acid solution, and add excess of solution of carbonate of potass, unless a precipitate commence soon, boil some time, for one to appear. Into a test tube put a portion of the dilute solution, and add a little dilute sulphuric acid, or of solution of sulphate of potass; a precipitate will result when the base is No. 5; or, if it be No. 4, hydrofluosilicic acid will give a white one in two days. But, when boiling fails likewise, supersaturate with ammonia, and then add solution of sal ammoniac; this solution test, with the solution of an oxalate, and a white precipitate will shew the base No. 6. But when the ammoniacal solution does not give a precipitate, test with phosphate of soda, and a white precipitate will shew the base No. 7.

The Acid of the Compound is thus discovered :— Moisten, with muriatic acid, a little of the powdered substance; heat; and effervescence, when an inodourous gas, will indicate that the acid is No. 6 of the series. But gas, with the offensive odour of sulphuretted hydrogen, will indicate the presence of sulphur and a metal. When the powder, on red coals, quickly burns, with additional heat and flame, the acid is No. 2. When mixed with soda, and heated in the inner flame of the blow-pipe, a garlic odour indicates the acid is No. 4. A fluoride and a borate are ascertained by the previous process (*e*,) and a chloride, by dissolving the powder in cold nitric acid. Then dilute much, and the solution of nitrate of silver causes a white precipitate. Or, to the nitric solution, add solution of nitrate of barytes; or to the muriatic solution add solution of chloride of barium. When either causes a white insoluble precipitate, the acid is No. 1.

In nitric acid, heat the powder long; the reaction and evolution of nitrous acid vapour, and deposit of sulphur; and, when the solution supplies, to solution of nitrate of barytes, a white insoluble precipitate, a sulphuret is present. When mercury is combined with sulphur, nitro-muriatic acid is required; and the gas evolved is chlorine. Also for tin and antimony, similarly combined (but not for lead;) and the deposit is the sulphate of lead, the peroxide of tin, and the protoxide of antimony. And mix the powder, with protoxide of lead, fuse on charcoal by the blow-pipe, and when the salt crystallizes by cooling, it will indicate that the acid is No. 3.

Neither water nor acids will dissolve some compounds; viz. highly ignited arseniates, acid phosphates, chloride of silver, protochloride and sulphuret of mercury, and sulphates of barytes, of strontian, of lime, and of lead. But the base and acid of such compounds are thus discovered :—

Mix a little of the powder with soda, or moisten with sulphuric acid; by blowpipe heat on charcoal; a green flame indicates the acid No. 3. In concentrated sulphuric acid, boil phosphates and arseniates; and, when the base is not No. 4, 5, 6, or 16, the resulting compound will dissolve in water; which is to be subjected to processes 1. *f* and 2. *b*.

In nitro-muriatic acid dissolve the compound; a deposit of sulphur; and an insoluble precipitate, on adding baryta salts to the solution, when diluted, indicate the base as sulphuret of mercury. And solution of caustic potass causing a yellow precipitate, indicates No. 21. In the test tube, add soda to the compound; heat; and the mercury will appear in globules. Without soda, the red or black sulphuret of mercury sublimes, unaltered, into a red powder.

With hydrosulphuret of ammonia, moisten the powder. When the previous white colour becomes black, there is present protochloride of lead, chloride of silver (often greyish black, and when fused yellow,) and sulphate of lead, distinguished thus (and also by the blow-pipe.) In a test tube, by a lamp, heat the powder; when it sublimes, protochloride of mercury; or fuses, chloride of silver; or is unaltered, sulphate of lead; will be indicated.

In water, boil the powdered substance and filter; then, to one portion of the solution add solution of chloride of barium to the other solution of an oxalate, and a white precipitate in both, that of the former insoluble in acids, will indicate sulphate of lime.

The powder boil in solution of carbonate of potass, or of soda; filter; supersaturate with dilute muriatic acid; test with solution of chloride of barium, and an insoluble precipitate will indicate the presence of the sulphate of either barytes or strontia; which is thus ascertained: to the boiled ley add muriatic acid; filter; concentrate much by evaporation; add alcohol, and inflame; a red flame shews sulphate of strontia, otherwise, sulphate of barytes. Or, test with hydrofluosilic acid; and, after two days, there will be a white precipitate, when sulphate of barytes is present; but none when there is sulphate of strontia.

*When the compound has several components, and yet readily dissolves in water*, the bases are discovered by a varied series of processes, now to be detailed.

The process (1.) will shew whether acid must be employed.

In water dissolve the compound, concentrate by evaporation, and add sulphuretted hydrogen till the solution is odourated; warm, and a precipitate will indicate the bases in No. 15 to 25, (or 14, when white and milky, sulphur; or, acid 4, when yellow, and soluble in hydrosulphuret of ammonia.) Decant off, and preserve the supernatent liquid.

The precipitate mix with ammonia; then add excess of hydrosulphuret of ammonia. Complete solvency or solubility indicates the bases in No. 22 to 25. Add water to the solution; then acidulate with muriatic acid, and the sulphurets will precipitate, each with different colour (a little paler by the sulphur present.) In five test tubes put a little of the dilute solution; to one add a few drops of clear solution of protochloride of tin, and a red precipitate; to another, likewise of protosulphate of iron, and a brown precipitate will indicate the presence of base No. 22. When the dilute solution is milky, and changes to red purple, by adding dilute solution of gold, the presence of No. 23 is indicated. When the first solution, acidulated, becomes milky, by being much diluted, or gives a precipitate, a yellow colour indicates No. 24; a red, No. 25. Or, mix the first precipitate with soda, and subject to inner flame of blow-pipe; a smoke off the bead, and then reticular crystals, shew No. 25, not No. 24.

When the precipitate first mentioned in the preceding paragraph is either partially or wholly insoluble, the bases are in No. 15 to 21. Dilute the solution, filter, supersaturate with muriatic acid, and a milky appearance, without precipitate, indicates insolubility; as likewise does total evaporation of filtered solution on platinum foil, heated to red heat over a lamp. The precipitated sulphuret filter on a very small filter, wash well, then digest both filter and its contents in strong nitric acid, by heat, and when the freed sulphur is yellow, filter it out. Unless the acid be highly concentrated, sulphuret of mercury will remain black after digestion; mix it with soda in a test tube, and heat by blow-pipe: when the sublimation does not alter it, there is present base No. 21; but if it alter to a grey powder, which, on being rubbed with a glass rod, forms globules, it is No. 20. The residual sulphur may combine sulphate of lead, when the compound had No. 16 present; but the acid would dissolve much of this. Put portions of the acid solution first formed into four test tubes; to one add excess of ammonia, and the colour will be blue when No. 18 is present. To a second add muriatic acid and white precipitate; insoluble by dilution, soluble by adding ammonia, will indicate No. 19. To a third, dilute sulphuric acid; a white precipitate indicates 16. The fourth, heat much, to dissipate the acid; add much water, and a milky appearance will indicate No. 17. The precipitated sulphuret, first made, mix with soda, and by blowpipe heat on charcoal, in inner flame, and a brown red (not yellow) powder shews No. 15.

The watery solution, first left, evaporate on platinum foil; when there is no remainder the solution is without fixed bases, but any remainder will be in No. 14 to 8. The liquid supersaturate with ammonia, then by hydrosulphuret of ammonia; precipitate, filter, and wash with water odourated by the hydrosulphuret: digest in dilute muriatic acid, both precipitate and filter till without odour of sulphuretted hydrogen. Employ a little nitric acid when 12 or 11 is present. Filter, and heat the precipitate in a little nitric acid; add excess of ammonia: a precipitate which, when filtered, and well washed, is white, indicates No. 8; but brown will be No. 8 and No. 14, thus separately distinguished:—Dissolve, filter, and precipitate in muriatic acid; filter the solution, add excess of solution of caustic potass, and No. 14 will precipitate; pour off the liquid, add solution of muriate of ammonia, and No. 8 will fall as a white precipitate. And, if a solution of gold cause a brown metallic precipitate, the base was then No. 13. When the ammoniacal solution is blue No. 12 is present; rose red, No. 11; also when the blow-pipe flame gives to this and borax a blue colour. To the solution add solution of caustic potass; a precipitate, bright apple green, indicates No. 12; but one, brown, No. 9. The precipitate, mixed with soda, heated on charcoal by blowpipe, gives a white metallic powder of No. 12; or a bead of amethystine hue, No. 9, green when on platinum foil. The liquid just left treat with hydrosulphuret of ammonia, and the precipitate roast on charcoal, by blow-pipe. Amethystine or green, No. 9; white oxide, No. 10, or green, by nitrate of cobalt; grey and magnetic No. 11.

When drops of the solution (first noticed in the preceding paragraph) wholly evaporate, cease the processes. But when there is a remainder, Nos. 7, 6, 5, 4, 2, 1, may be present.

By excess of muriatic acid decompose the excess of hydrosulphuret of ammonia, and heat till without odour of sulphuretted hydrogen; filter out the sulphur, add excess of solution of carbonate of ammonia, volatilize by heat the carbonic acid, and the precipitate indicates No. 6 to 4. Dissolve the precipitate in muriatic acid, add dilute solution of sulphate of potass, or a little sulphuric acid; a precipitate immediately may be of all three, but if only after some time, only 6. To the dilute solution, add excess of dilute sulphuric acid; heat, and filter the precipitate; the liquid left supersaturate with ammonia, and test with solution of oxalic acid for No. 6; which, if present, will ultimately appear; and then must be obtained from the sulphuric liquid. When 6 is absent, the precipitate is 5 or 4, or both; the former will not precipitate, after hydrofluosilic acid has been added some hours, but the latter will. A little of the precipitate heat long on charcoal by inner flame of the blow-pipe; then dissolve in muriatic acid, and evaporate dry on platinum foil; place the salt on long wedge-shaped strip of paper; add alcohol and inflame. Red indicates No. 5 alone, or with 4 (found as just mentioned;) but any other colour indicates absence of No. 5.

When drops of the solution, after the precipitate first noticed in the preceding paragraph, evaporate wholly on platinum foil, the processes are ended; but if there be a remainder, add solution of phosphate of soda, and a white precipitate is No. 7. But when no precipitate falls, evaporate the solution altogether; in a porcelain crucible volatilize all the ammoniacal salts; dissolve in alcohol and water, and add solution of chloride of platinum. A bright yellow precipitate is No. 1; when no precipitate falls, No. 2 may be present, and also with one, which is ascertained by dipping a platinum wire in the calcined mass, and in the inner flame of blowpipe a *blue* colour shews No. 1; a yellow, No. 2; or 1 and 2 together. The solution of the previous process evaporate dry, ignite the mass, next dissolve in water, and add excess of acetate of barytes, which will affect any sulphuric acid, and a proportionate quantity of sulphate of barytes will be precipitated. The liquid left now may combine with the excess of acetate of barytes, acetates of magnesia, soda, and potass. Evaporate dry, ignite the mass, and dissolve in water the alkalies present, while the barytes and magnesia remain unaffected. Strong ignition will dissipate the carbonic acid, and the magnesia will be caustic yet insoluble. Add muriatic acid to the alkalies, to form chlorides, and distinguish them as already mentioned. The native compound in powder heat in solution of caustic potass, and a glass rod, moistened with muriatic acid, held over it, will cause white vapours, when No. 3 is present.

*The acids of these compounds are ascertained thus*:—Test the concentrated solution, add dilute muriatic acid, and when 6 is present and 9 is absent, there will be effervescence, and an inodourous gas; but when the gas is odourous, a sulphuret of a metal is present, and 6 may be also present.

To a solution not acid add solution of chloride of barium (except the presence of 16, 19, 20, require the use of nitrate of barytes,) and a precipitate indicates that 1, 3, 4, 5, 7, (and 6 when precipitated by chloride) may be present. Employ nitric or muriatic acid, (as proper) diluted, and when the precipitate is wholly re-soluble, 1 is absent, when effervescence ensues, and there is no sign of precipitate from a slight acidulation and boiling, and saturation with ammonia, 6 is present alone. But when these affect it, 6 and 1 or several of the others may be present, or there may be only 3, 4, 5, and 8, present.

Put portions of the solution in four

test tubes, and to them severally add to 1, sulphuric acid, and cover with glass plate waxed and traced; corrosion shews 3 present. To the second, sulphuric acid and alcohols inflame; a green colour indicates 5 present. To the third, liquid sulphuretted hydrogen, a precipitate indicates 4, (always with alkalies only, and so free from metallic tint of colour, and its metallic and earthy compounds being soluble in only excess of acid.) To the fourth, solution of chloride of barium, or chloride of calcium, a precipitate (soluble in muriatic or nitric acid, and again falling to excess of ammonia) proves 3 present.

The solution of the compound odourate with liquid sulphuretted hydrogen, boil and filter out the sulphuret of arsenic. Neutralize the liquid, and solution of chloride of barium, or chloride of calcium, will, when 3 is present, cause a precipitate, insoluble in excess of water, or 5 when soluble therein. Into a platinum crucible put the compound with sulphuric acid, heat till vapour ceases, dissolve the mass in water, add muriatic acid, and then solution of chloride of barium; filter out the precipitated sulphate of barytes, add excess of ammonia to the liquid, and a second precipitate is No. 3. But when the precipitate by chloride of barium is only partially soluble in muriatic or nitric acid, 1 is present; and treat the liquid by the methods already mentioned, to ascertain the presence or absence of 3, 4, 5, and 8. When in solution of compound, nitrate of silver causes a white precipitate, insoluble in dilute nitric acid, a chloride is present. And 2 is present when the compound deflagrates on glowing coals.

The bases which are discovered in those *compounds only partially* or wholly insoluble in water, though soluble in muriatic and nitric acids, may by the following processes be ascertained :

Whatever portion of the mass dissolves in water, subject to the processes just detailed, but the portion which remains insoluble, treat by these now particularized.

The acid solution treat with liquid sulphuretted hydrogen, and the precipitate which results filter out, and mix with hydrosulphuret of ammonia; the second precipitate will be No. 24, 25, or acid 4 (proved by adding soda, and fusing with blow-pipe.) The precipitate dilute, and when 25, muriatic will decompose it. The ammoniacal solution dilute, and muriatic acid will cause a precipitate, which dry, and in a glass tube well-secured from air, by heat sublime the sulphur, and any sulphuret of antimony present. (In the minimum of sulphur, are the sulphurets of tin and antimony.) In concentrated muriatic acid dissolve the sulphuret, dilute, and then add solution of gold, which will cause a purple colour when No. 24 is present; but will disturb the solution and cause a brown precipitate when the base is No. 25. That portion of the precipitate first noticed by the ammonia may combine No. 15 to 21, as will be proved by the processes of the preceding section.

By evaporating some drops of the solution on platinum foil over a lamp, ascertain whether any fixed bases remain; and when they do, to the solution add excess of ammonia, then test with hydrosulphuret of ammonia, and there will be a precipitate of No. 14 to 8, or 7 to 4, and acid 3 or 5, or a metal with fluorine. Digest in the proper acid, as before.

Filter the acid solution, (and heat nitric acid;) add dilute sulphuric acid, and sulphurets of 5, or 4 (or 6, when in excess and the solution is not very dilute); filter, wash the precipitate, and what dissolves will be proved No. 6, by solution of an oxalate; the remainder is 5 or 4, as the blow-pipe will again prove; by a red flame 5 alone. But, as both 5 and 4 may be together, and the flame not be red, the precipitate may be boiled in a solution of carbonated alkali (soda or potass,) and when settled, test the liquid for No. 4 with fluoric acid, and for 5, treat the precipitate with muriatic acid. The solution, first left, treat with excess of ammonia, and a precipitate is No. 14, or 8, (or 7, with acid 3.) Boil the precipitate in a solution of caustic potass, No. 8 is soluble, 14 insoluble, as is 7 when not with acid 3, filter the solution, treat with solution of sal ammonia, and No. 8 will be precipitated; and the insoluble precipitate, under the blow-pipe, when 14, will be very plain, or dissolve it in muriatic acid, and add excess of ammonia and 14 will precipitate. Add to the liquid phosphate of soda; a precipitate is No. 7. And for No. 12 to 9 in the previous filtered liquid, proceed as directed in the previous section for those bases, also the solution first formed by the ammonia above.

*The acids in such compounds* are thus ascertained :—Put some of the powder into dilute muriatic acid, effervescence and a gas inodourous indicates 6, but gas odourous, sulphur and a metal. Put the materials into a glass tube, having a perforated cork, with a thin glass tube bent twice at a right angle, one end introduced into an ammoniated solution of chloride of barium, and closed from atmospheric air, and when 6 is present, there will be a white precipitate, soluble and effervescing in muriatic acid. Nitric acid is proper for 16, 19, or 20, and solution of nitrate of barytes; or dissolve the compound in muriatic acid, dilute well, add solution of chloride of barium, and a white precipitate indicates acid 1. In nitric acid heat some of the powder, a yellow vapour of nitrous gas, and deposit of sulphur, and the acid solution, filtered, and diluted, and in which solution of nitrate of barytes cause a white precipitate, a sulphuret is present, and when of mercury, while decomposing in nitro-muriatic acid, chlorine evolves.

The powder dissolve in nitric acid, (without heat, when possible,) dilute test with solution of nitrate of silver, and a curdy precipitate indicates 7. Put a little of the powder in platinum crucible, add sulphuric acid, and cover with traced glass to ascertain No. 8; by glowing coals ascertain 2, and 4 by the blow-pipe. When 1, 4, 5, and 9, are absent, by blow-pipe test for 3. And by heat expel the sulphuretted hydrogen from the liquids; neutralize by caustic potass, test for 5, and 8, and for 3 by blow-pipe.

The ammoniacal liquids with compounds of bases precipitable by hydrosulphuret of ammonia, (likewise employed for 14 to 9,) heat till free from odour of hydrogen; filter out the free sulphur, and test for 3. Some difficulty occurs with bases 8 to 4, and metallic oxides thus precipitated. The sulphurets precipitate by adding liquid sulphuretted hydrogen; to the liquid left add excess of ammonia, and when 3 is present, the earths 4, 5, 6, 7, precipitate. By blow-pipe ascertain the presence of 3; and by tests the absence of 5 and 8. When muriate of ammonia is present, and 3 is absent, the ammonia does not precipitate 7; yet it does 8, whether 3 is or is not present;—ascertained by the blow-pipe.

When the compound contains 8 to 4, also 14 to 9, and metallic oxides precipitable from acid solutions by liquid sulphuretted hydrogen; in muriatic acid dissolve the powder, and by liquid sulphuretted hydrogen precipitate the metals it affects; filter; by heat dissipate the odour; and add dilute sulphuric acid; a precipitate is 5, or 4, (or 6, when insoluble on adding alcohol;) filter; (and for 6, by heat volatilize the alcohol.) When 8 and 7 are absent, and yet metals remain, precipitable by hydrosulphuret of ammonia; treat with ammonia, add hydrosulphuret of ammonia, filter out the metals, and test the liquid for 3, as before directed. But when 8 and 7 are present, boil with excess of caustic potass; the precipitate is 13 to 9, with minimum of 3 acid; add muriatic acid, and chloride of barium will be present, the precipitate is sulphate of barytes; filter, add ammonia, and precipitate phosphate of barytes. When 8 and 10 are present, acid 3 dissolves with them in caustic potass. Add hydrosulphuret of ammonia, 10 will precipitate, and test for 3 acid; or, for 8 and 3, proceed as just directed. When 8 and 10 are both present, to the alkaline solution add hydrosulphuret of ammonia, and precipitate sulphuret of zinc; by heat decompose the excess of the hydrosulphuret of ammonia, and test for 8 and 3.

*Some portions of compounds remain insoluble after the others have been dissolved by water, or by acid;* as sulphates of barytes, of strontian of lime, and of lead; chloride of silver; protochloride, and sulphuret of mercury. In a glass tube, closed at one end, highly heat some of the very dry insoluble remainder; and when it wholly sublimes unaltered, it is mercury in the state of protochloride, (black, in ammonia; or, when red, it is sulphuret;) but if globules appear, some other free base or metal is present. When a portion does not volatilize, it is either chloride of silver, or sulphuret of lead, lime, strontian, or barytes. In a crucible (of platinum, silver, or porcelain, according to the nature of the compound,) with thrice the weight of carbonate of soda, fuse the unvolatilized remainder; when cool, immerse in water to soften; add more water, digest well, filter, and add excess of nitric acid. Solution of nitrate of barytes will detect any sulphuric acid present; and solution of nitrate of silver will precipitate chloride of sodium, when chloride of silver is present. The substance on the filter will be carbonate of barytes, strontian, lime, or lead; with metallic silver when its chloride was present. The heat will form the silver into a bead in the crucible, and that portion not fused may be very fine in the watery mass. When silver and lead are absent, employ muriatic acid; when present, nitric acid, to dissolve the filter and its contents; test with dilute muriatic acid, No. 19 will precipitate as chloride of silver; filter; to the liquid add caustic ammonia, a white precipitate is No. 16. By liquid sulphuretted hydrogen separate 19 from 16. The filtered liquid test with fluoric acid for 4; or with solution of sulphate of potass, or very dilute sulphuric acid, for No. 5 alone, or with 6 (immediately precipitated,) filter out 5; and an oxalate will find 6.—*Simeon Shaw.*

ANATOMY is the art of dissecting man; that of brutes being called *Zootomy.* Mondini di Luzzi, professor at Bologna, first publicly dissected two corpses, in 1315, and soon afterwards published a description of the human body. From this time it became customary, in all universities, to make public dissections once or twice a year. In the 18th century Pacchioni, Valsalva, Keil, Lancisi, Ruish, Haller, Boerhaave, Vicq-d'Azir, and others, distinguished themselves by their skill in anatomy. Meckel, Soemmering, Loder, Sheldon, Bichat, Rosenmüller, are worthy to be mentioned as renowned anatomists of later times. According to the parts of the body described, the different divisions of anatomy receive different names; as, *Osteology*, the description of the bones; *Myology*, of the muscles; *Desmology*, of the ligaments and sinews, &c.; *Splanchnology*, of the viscera or bowels, in which are reckoned the lungs, stomach, and intestines, the liver, spleen, kidneys, bladder, pancreas, &c. *Angiology* describes the vessels through which the liquids in the human body are conducted, including the blood-vessels, which are divided into arteries and veins, and the lymphatic vessels, part of which absorb the chyle from the bowels, while others are distributed through the whole body, absorbing the secreted humours, and carrying them back into the blood. *Neurology* describes the system of the nerves and of the brain. *Dermology*, of the skin.

ANATOMICAL PREPARATIONS. Dead bodies and parts of bodies, notwithstanding their tendency to decomposition, can be preserved by art. It is important to the physician, for the determination of the medical treatment proper in similar cases, to preserve the organs, which have been attacked by diseases, in their diseased state, and, as a counterpart, the same organ in its sound condition. The anatomical preparations of healthy parts may serve for instruction in anatomy. Preparations of this sort can be preserved either by drying them, as is done with skeletons, or by putting them into liquids, *e. g.* alcohol, spirits of turpentine, &c. as is done with the intestines and the other soft parts of the body, or by injection. The injection is used with vessels, the course and distribution of which are to be made sensible, and the shape of which is to be retained. The beginning of the vessel, *e. g.* the aorta among the arteries, is filled, by means of a syringe, with a soft, coloured mass, which penetrates into all, even the smallest branches of the vessels, dries them, and makes them visible. The finest capillary vessels may be thus made perfectly distinguishable. The infusion usually consists of a mixture of soap, pitch, oil, and turpentine, to which is added a colouring substance; for instance, red for the arteries, green or blue for the veins, white for the lymphatic vessels. For very fine vessels, *e. g.* for the absorbing lymphatic vessels, quick-silver is preferred, on account of its extreme divisibility. Dried preparations are the bones cleared of all the soft parts by boiling, and bleached, or any of the soft parts, covered with a protecting but transparent varnish; *e. g.* muscles, intestines, &c. The quicker the drying of the organs destined for preparation can be effected, the better they will be preserved. For the purpose of preserving them, alcohol is used; the more colourless, the better. Spirits of wine, distilled with pepper, or very strong pimento, are also used, together with some muriatic acid. Washing with acids (and lately pyroligneous acid has been used,) gives to the preparation sometimes firmness, and sometimes whiteness. Washing is particularly necessary with bones which are in a state of putrefaction. Muscles are usually tanned; and all that is in danger of being eaten by worms, or injured by a damp atmosphere, is covered with a suitable varnish. The preparations treated thus are fixed upon a solid body, or in a frame. Preparations preserved in liquids are usually kept in transparent glasses, hermetically sealed, to secure them from the destroying influences of dust, air, humidity, heat, cold, the sun, insects, &c. Damaged preparations can seldom be perfectly restored.

The injections used in London are of several kinds:—

*Coarse injection.* Take of tallow, bees-wax, common resin, of each equal parts. Colour, (vermillion, or red lead) 1½ oz. to a pint. Melt them over a slow fire, and gradually mix in the colour.

For corroded preparations. Take of common resin and bees-wax of each equal parts. Colour, 1½ oz. to a pint. *Minute injection.* Take of double size, 1 pint; best glue, 1 oz.; colour, 1½ oz. For *very delicate preparations*, as the eye, a solution of isinglass is to be preferred.—*Dewhurst.*

*Comparative Anatomy* is the science which compares the anatomy of different classes or species of animals; *e. g.* that of man with quadrupeds, or that of fish with quadrupeds. It is a science which has greatly increased our knowledge of nature, and affords one of the most interesting subjects of study. Cuvier is the great master of this science.

ANATRON; the scum which swims upon the molten glass in the furnace, sometimes called *sal vitri*, which, when taken off, melts in the air, and coagulates into common salt. It is also that salt which gathers upon the walls of vaults; likewise the same with *natron.* Anatron is also a compound salt, made of quick-lime, alum, vitriol, common salt, and nitre, used as a flux to promote the fusion and purification of metals. It is also used for the *terra saracenica.*

ANCHOR, is an important, strong, and heavy instrument of iron for holding ships in harbour. It consists of a shank having at one end a ring, to which the cable is fastened, and, at the other end, two arms or flukes, with barbs or edges on each side, intended to be dropped from a ship into the bottom of the water, to retain her in a station. The most ancient anchors are said to have been of stone, and sometimes of wood, to which a great quantity of lead was usually fixed. In some places, baskets full of stones, and sacks filled with sand, are employed for the same use. All these are let down by cords into the sea, and, by their weight, stay the course of the ship. As improved, they are composed of iron, and furnished with teeth, which, being fastened to the bottom of the sea, preserve the vessel immoveable. At first, there was only one tooth, but, in a short time, the second was added. The anchors with two teeth, from ancient monuments, appear to have been much the same with those used at present, only the transverse piece of wood upon the handles (the stocks) is wanted. Every ship has several anchors, one of which surpasses all the rest in bigness and strength. 1. The *sheet* anchor is the largest, and is only used in case of violent storms. 2. Two bower anchors, viz. the *best bower* and *small bower*, so called from their situation at the bows. 3. The *stream* anchor, the *kedge*, and *grappling*, or *grapnel*. The three last are often used for moving the ship from place to place, in a harbour or river.

The anchor is said to be *a-peak*, when the cable is perpendicular between the hawse and the anchor; it is said to *come home*, when it does not hold the ship; it is said to be *foul*, when the cable gets hitched about the flukes. To *shoe* an anchor, is to fix boards upon the flukes so that it may hold better in a soft bottom. *Riding at anchor* is the state of the vessel when moored or fixed by the anchor. *Dropping* or *casting anchor* is letting it down into the sea. *Weighing anchor* is raising it from the bottom.

The weight of our modern anchors is determined by the length of the shank, and is in lbs. the cube of the length in inches divided by 1160; for the parts of every anchor are exactly proportionate. The two arms are in a circle, whose centre is three-eighths of the shank from the vertex, and each arm is 60°, or equal to the same length, or to the radius. The flukes are half the length of the arms, and two-fifths broad. The thickness or circumference at the vertex of the shank is a fifth of the length. A vessel 8 feet wide requires an anchor of $3\frac{1}{5}$ ft. in the shank, weighing 33 lbs. A vessel 12 ft. broad, of $4\frac{4}{5}$ ft., weight 110 lbs.; 20 ft. broad an anchor of 8 ft., weight 512 lbs. A vessel of 30 ft. of 12 ft. and 1728 lbs., 40 ft. of 16 ft. and 4096 lbs., and 45 ft. of 18 ft. and 5832 lbs. Anchors are made of wrought-iron.

Anchors are usually made by combining several small bars of iron united together, by welding them into solid masses. This mode is preferred to a single bar of sufficient size, because the compounded bar is not liable to have any internal flaws or cracks, or at least they are not in a transverse direction. If, after the welding, any cracks are left between the bars, they must be in the length of the anchor, and therefore will not abate from the strength.

The hearth of an anchor-smith's forge is built of brick-work, raised about 6 or 9 inches above the ground, and 6 or 7 feet square. In the centre is a large cavity, to contain the fire; at the back of the hearth a vertical brick wall is erected, supporting and forming one side of the chimney, which is little more than a doom placed over the hearth, and opening at top with a low chimney to carry off the smoke. Behind the wall the bellows are placed; the noses of the pipes being about the level of the hearth, and coming through the wall; which at that part is defended from the action of the fire by a facing of fire-stone. In this fire-stone the tue-iron is fixed; it is a tube, made of wrought iron, and very thick in the substance, that it may not burn away in the fire; the pipes of the bellows are inserted in the tue-iron, and thus convey the stream of air into the centre of the fire.

The bellows are not like those which ordinary smiths make use of; but two large pair of single bellows are placed horizontally by the side of each other, the pipes of both being inserted into the same tue-iron, and directed to blow to the same focus, in the centre of the fire: these bellows are exactly like those in use for domestic purposes, which only throw out air when the upper board is pressed down. The two are worked alternately by means of chains, attached to the ends of the upper boards, and united to the end of working levers, placed over each pair of bellows. From the opposite extremities of these levers, other chains are extended to the opposite side of a long lever which moves upon the pivots of a vertical axis, and is loaded at the ends by heavy weights, to give it *momentum*. Now two or more men, pushing in opposite directions, can give it a motion backwards and forwards, and by the communication of the chains and upper levers, they alternately lift up the upper boards of the bellows, which being sufficiently loaded, will subside themselves, and force their contents of air into the fire. The men who work the lever are aided by six or eight more, who place themselves upon the board of one pair of bellows, and as soon as it subsides, they step upon the other pair, which also sinks, and then they return: they have ropes suspended from the roof to enable them to lift themselves, and mount from one bellows upon the other with more ease. The common tue-iron, which is simply a cone of wrought iron, set with clay into fire-stone, composing the back of the hearth, is very soon burnt by the great heat. The most improved forges, therefore, are now furnished with what is called the water tue-iron; which is made hollow, and water introduced into it to keep it cool. For this purpose, two cones are formed of thick iron plate, each with a small aperture at the vertex; these, when put one into the other, are welded together at their bases and their points, so as to form one cone, which is hollow, with a small space all round; two pipes communicate with the hollow, one bringing a continual supply of cold water, and the other conveying away that which is heated by the fire. By this means the tue-iron is kept cool, and can never acquire any such degree of heat as to be burned away: this tue-iron is set with fire clay into a frame of cast-iron built up in the brick-work of the wall.

The anvil is only a cubic block of cast-iron placed on the ground, much lower than the ordinary smith's anvil; because, as the anchor-smiths always strike by swinging their hammers over their heads, at arms length, they have more force when the work lies low on the ground than if raised up. At a distance of eight or nine feet from the hearth a strong crane gib is erected, so as to turn freely upon a vertical post; it has no tackle, but the upper beam, which must be horizontal, has a large iron hoop hung upon it, with a roller, which admits it to run freely backwards and forwards upon the beam; the lower end of the loop suspends the anchor; therefore, by moving the rollers along the beam of the gib, and by turning the gib round on its pivots, the anchor can be placed in any position in the fire or upon the anvil. To give motion to the roller, a rack is connected with it; and this is moved by a pinion upon the axis of the wheel, which has an endless rope hanging down, so that a labourer can reach it, and thus remove the anchor nearer or farther from the centre, however great its weight may be.

The workmen employ scarcely any other tools than their sledge-hammers, and a few large punches, cutting chissels, and sets or prints, which, when urged by the hammers, will give any particular figure to the work: the hammers are of the largest kind, and weigh from 14 to 18 lbs., according to the strength of the workmen. In the royal dock-yards great use is made of a stamping machine, which the workmen call Hercules; and which is very similar to the machine for driving piles. A heavy iron weight, guided like the ram of the pile engine, is drawn up by the strength of several men, and let fall upon the anchor, to weld the bars, in the same manner as by a forge-hammer. The machine is erected on a large block of stone, which supports the anvil; two square iron bars are fixed on each side of the anvil in a vertical position, the angles of the bars being placed towards each other. These vertical bars are eight or nine feet high, and are fixed at the top to a beam in the roof of the building, in which the machine is placed; a ram which weighs 4½ cwt. is fitted to slide up and down between the bars, having notches in its sides which receive the angles of the bars; it is drawn up by a rope passing over an iron pulley, mounted upon pivots above the top of the vertical bars; and the rope has eight or ten small ones, spliced into it, for as many men to act together (which they do by a similar motion to that of ringing,) to elevate the ram, and let it fall upon the iron, placed upon the anvil. The Hercules is placed in the same sweep of the crane as the anvil, so that the iron can be conveyed to either with equal ease.

The parts of the anchor are all made separately, and afterwards united together. The first step, in making the parts, is to assemble or faggot the bars. For the centre of the mass, which is to make the shank, four large bars are first laid together; then upon the flat sides of the square so formed, smaller bars are arranged to make it up to a circle. The number is various, but in large anchors six or eight bars are laid on every side; this circle is surrounded by a number of bars, arranged like the staves of a cask; as many as thirty-six are often used, and form a complete case for the others. The ends are made up by short bars to a square figure; the faggot is finished by driving iron hoops upon it, at sufficient distances; and it is suspended from the crane in such a manner, that it can be moved and turned in any direction, by only one or two men, even when it weighs three tons. For this purpose, an iron pulley is hooked to the iron loop of the crane, and a short endless chain, passed over the pulley, suspends the faggot in its loop. In this manner, the weight of the iron is, in reality, borne by the pivot of the pulley, and the mass can be easily turned round upon its centre to bring any side upwards. To give a power to the man who guides it, one of the four central bars is double the length of the faggot, and projects, to form a long lever, by which it is steered; and two holes are made through the end of this bar to insert a cross lever, by which the faggot is turned or rolled round upon its centre. As the faggot hangs very nearly on a balance in the loop of the chain, the man, by weighing on the end of the long bar, can easily raise up its end from the anvil; and, swinging the crane on its pivots, he can move it into the fire.

*Mooring Anchors* are one of the largest anchors, used for first-rate ships, as 80 cwt., having one of the arms bent close down upon the shank, to prevent it catching the cable, or mooring-chains, whilst the ships are riding. These anchors are lowered down into the water with a very strong iron mooring-chain fastened to the ring, to which various ships are fastened. The palm, or heavy part of the anchor, is made very massive of cast-iron, and of considerable breadth, so that the part which enters the ground may have a great hold; the shank is made also of cast iron, and fixed firmly to the head, by passing through it, and has a small ring, where the buoy-rope is fixed; the other end of the shank goes through the stock, which is formed of two large wooden beams, hooped together in the same manner as the stocks for common anchors; the end of the shank projects through the stock, and has a strong wrought-iron shackle fixed to it, by a bolt passing through both; and with this the mooring-chain is connected. The great advantage of this over the common mooring-anchors, arises from its great weight and breadth of edge to act against the ground; and being made of cast-iron, it is also more durable. A pair of these anchors, weighing 150 cwt. each, will, with the mooring chains, cost about £874 less than a pair of the common anchors, which, with their chains, cost £2172.

Mr. Pering has lately improved the anchor, in the formation of the parts, by flat plates or bars of iron, placed edgewise to the line of resistance. By this structure, it is not necessary to the strength of the anchor that the inner plates should be welded together; compared with an anchor faggotted in the usual way, and rendered completely solid by welding, it is very much stronger; as the flat plates, by successive rolling, become fibrous, and acquire a greatly-increased strength over a more crystallized iron. When these flat bars are firmly welded on the outside, the greatest strength is attained in the direction of each part, and every part of Mr. Pering's anchor is thus formed of layers of plates, placed edgewise to the strain to which it is liable. This is accomplished at the crown, or joining of the shank to the arms; the plates at the lower end of the shank are split through their sides and turned, edgewise of the layers, on either side, so as to form the inner part of the arms. The outer is formed likewise of plates turned edgewise, and overlaying the inner part, thus continuing the fibrous course and strongest resistance of the iron through that part of the anchor which had always been the weakest. Some improvements in the form have also been made by Mr. Pering, by giving a curve to the arms from the fluke or palm, to the crown, which places the fulcrum nearer the resting end of the lever, at the moment when its resistance is greatest in raising the anchor.

Several trials have taken place at the dock-yards. The first, April 1813, of 24 cwt. it broke a 24 cwt. 29 cwt. and 35 cwt. At Chatham, 11th April, 1815, against one of 25 cwt.; Portsmouth, in May 1816, 48 cwt.; at Plymouth, 1831, of 53 cwt. In the last, the trial was made against a hollow-shanked anchor; the two anchors opposed bore great power. The mode of trial was by placing the toes or points of the flukes against two large bollards firmly propped; two three-fold blocks were then lashed and reeved to the ring of each anchor by a nine-inch hawser; the standing parts of each were carried to two capstans, one on either side, which capstans were manned by a hundred men to each; on the two first heaves, the two toes or points of the arms of the hollow-shanked anchor gave way; on the two last heavings, the two arms of Rogers' anchor gave way in three places, the whole of which was sustained on one arm only of Pering's. The strain was so great that it brought the hundred men at each capstan to a stand still, and may be calculated at about 350 tons dead weight.

ANCHOVY, the common species (*clupea enchrasicolus*, L.) is about a span long, brownish on the back, with argentine belly and flanks. It is found in the greatest abundance in the Mediterranean, on the coasts of France, England, and Holland, whither they come in immense shoals, like the larger herrings, for the purpose of spawning.

ANDERSON'S Scots' Pills. Mix Barbadoes aloes 1 pound, with black hellebore root, jalap root, and subcarbonate of potass 1 ounce each, and 4 drams of oil of aniseed, with sufficient simple syrup.

ANEMOMETER, the, is a machine for measuring the force of wind. The common construction is 4 windmill-sails turning an axle shaped as a cone, on which a rope coils with a weight, so that the force of the wind balances as the rope coils round the large or small part of the cone. The trade-winds and land-breezes are 6 or 7 miles per hour. A fair sea-wind is 20 feet per second, or 16·63 miles per hour. A good sailor displays 0·33 of the direct wind; and a prime sailor 0·4. Hence the first, before a wind of 20 miles an hour, will sail 6·6 and the second 8 miles or knots an hour. Kirwan makes a brisk gale from 15 to 20 miles an hour, and Lind makes the force 2·6 lbs. to the square foot. A storm 32 to 34 miles, and 15·625 lbs. to the square foot.

ANEMOSCOPE, the, is the common instrument for determining the direction of the wind as N. S. E. or W., or either of the 8 points in each quarters, as N. N. by E., N. N. E., N. E. by N., N. E., N. N. E. by E., E. N. E., E. by N. and then E., so with the rest. Sometimes an Anemoscope has an index on the ceiling or wall of an apartment with the bearing of countries, seas, and ports marked at the several points.

ANEURISM, the swelling of an artery, or the dilatation and expansion of some part of an artery. This is the true aneurism. There is also a spurious kind of aneurism, when the rupture of puncture of an artery is followed by an extravasation of blood in the cellular membrane. If the external membrane of the artery is injured, and the internal membrane protrudes through, and forms a sac, it is called *mixed aneurism*. Lastly, there is the varicose aneurism, the tumour of the artery, when, in bleeding, the vein has been entirely cut through, and at the same time the upper side of an artery beneath has been perforated, so that its blood is pressed into the vein. The external aneurisms are either healed by continued pressure on the swelling, or by an operation, in which the artery is laid bare, and tied above the swelling, so as to prevent the flow of the blood into the sac of the aneurism, which contracts by degrees. Sometimes the ligature is applied both above and below the aneurism.

ANGELICA is a common plant, a decoction of the aromatic root of which, in boiling water, with the addition of brandy or alcohol, is stomachic and carminative.

Angelica Root is stomachic, carminative, aperitive, diaphoretic, and useful in typhus fever. The seeds are aromatic; when candied the fresh stalks (boiled in water to weaken the bitterness and strong scent) are put into syrup boiled to candy till quite dry, taken out, and dried. The cordial is aphrodisiac.

ANGLE, the inclination of two lines: measured by arcs of a circle, the centre of which is the point where both the sides of the angle meet, the *vertex*, as it is called in geometry. Every circle, large or small, is divided into 360 degrees, each degree into 60 minutes, each minute into 60 seconds. It is, therefore, clear that the size of the angle has nothing to do with the length of the lines, because only their inclination is measured. An angle of 6 degrees, 2 minutes, and 3 seconds, is written thus: $6^\circ 2' 3''$. Angles are divided into right angles, equal to 90°, four of which are equal to the whole circle; obtuse angles, those greater than 90°; and acute angles, those which are less. There are, also, spherical angles and solid angles; the former formed by arcs, the latter by planes.

Every triangle has 3 angles, which always are equal to 180°. When one of the sides is perpendicular to another side, that angle is 90°, therefore the other 2 are equal to 90° together, and if one is given we get the other by subtraction. Then the sides are in proportion to the angle opposite to them. The side opposite the right angle is called the hypothenuse, and the sides which enclose the right angle are the base and the perpendicular. Then, as all triangles which have equal angles are proportional, tables are prepared of the proportion of the other sides to a known side for every degree, minute and second of the angles. The tables suppose the known side to be 1,000,000, and the proportions of the others are given for every angle as under, taking the angle opposite the perpendicular or *sine*, the base being the *cosine*, and the hypothenuse always 1,000.

| Angle. | Perp. or Sine opposite the given Angle. | Base or Cosine including the angle with the Hypothenuse. |
|---|---|---|
| 1 deg. | 17 | 999 |
| 5 | 87 | 996 |
| 10 | 174 | 985 |
| 15 | 259 | 966 |
| 20 | 342 | 940 |
| 30 | 500 | 866 |
| 40 | 643 | 766 |
| 45 | 707 | 707 |
| 50 | 766 | 643 |
| 60 | 866 | 500 |
| 70 | 940 | 342 |
| 80 | 985 | 174 |
| 89 | 999 | 17 |

Each degree the inverse of the other, but these numbers are so important to navigators, surveyors, builders, teachers, &c. that they ought to be committed to memory.

ANGUSTURA BARK, or Cusparia, is the product of a tree, called *Bonplandia*, from its discoverer. It is an evergreen of 20 to 50 feet, and grows near

St. Fé. It is more stimulant than cinchona, and preferred in dyspepsia, &c. The species, *ferrugina*, yields *Brucia*, a deadly poison.

*Angustura Tincture.* Two pints of alcohol and two ounces of angustura bark. The dose of a dram to half an ounce is tonic and stomachic.

ANHYDRITE, a dry sulphate of lime, found in the salt-mines of Austria and Salzburg, and in lime-stone at Lockport, in New York. It presents several varieties of structure and colour. The vulpinite of Italy is the only one used in the arts. This possesses a granular structure, resembling a coarse-grained marble. Its color is grayish-white intermingled with blue. It is cut and polished for various ornamental purposes.

ANIMALCULES. Professor Ehrenberg, the German naturalist, has been for years prosecuting researches on these beings, and his discoveries "on the structure and functions of these animals form an epoch in science. In the midst of their transparent tissues, Ehrenberg has developed a highly complicated organization, which, with those who arrange the animal kingdom will remove them far from the extremity of the scale. The existence of a digestive, muscular, and generative apparatus is established beyond a doubt: and organs have also been discovered which bear great analogy with the vascular and nervous systems.

He supplied the Infusoria with organic colouring matter for nutriment. And after ten years' observations succeeded in selecting the fittest substances, and in applying them in the best manner. It was not till he used pure indigo, that his experiments succeeded. It is requisite to employ colouring matter which does not chemically combine with water, but is only in a state of very minute division. Indigo, carmine, and sap green, are three substances which answer best. Immediately on a minute particle of highly attenuated solution of indigo being applied to a drop of water containing some of the pedunculated Vorticellæ, the most beautiful phenomena present themselves. Currents are excited in all directions by the rapid motion of the ciliæ, which form a crown round the anterior part of the animalcule's body, and indicated by the movements of the particles of indigo in a state of very minute division in different directions, and generally all converging towards the orifice or mouth of the animal, situated, not in the centre of the crown of ciliæ, but between the two rows of these organs which exist concentric to one another. The attention is no sooner excited by this most singular and beautiful phenomenon, than presently the body of the animal, which had been quite transparent, becomes dotted with a number of distinctly circumscribed circular spots, of a dark blue colour, exactly corresponding to that of the moving particles of indigo. In some species, particularly those which are provided with an annular contraction or neck, separating the head from the body, the particles of indigo can be traced in a continuous line in their progress from the mouth to these internal cavities. He used a microscope possessing a power of 800; but a power of from 300 to 400 he found sufficient. For the purposes of measurement he used a glass micrometer, constructed by Dollond, which gives directly the ten thousandth part of an inch, and by means of a micrometer screw, he has been enabled to measure one forty-eight thousandth of an inch.

By such a microscope and micrometer, Ehrenberg has demonstrated the existence of a digestive system in all genera of the Infusoria. The ciliæ, which vary in number in different species, seem to be the principal agents by which they excite those currents which are so beautiful under the microscope, and which have the effect of bringing the nutritive particles infused in the water into contact with their mouths. An œsophagus belongs only to those which possess a contraction between the mouth and the stomach. Of the stomach some species have several; the Monas termo has four, and other species more; the stomach varies in form also, in different species. The alimentary canal presents, as in other classes of the animal kingdom, the utmost variety, in respect to form, situation, and degree of complication: the anus, also, in its figure and situation, exhibits much variety.

In the muscular system of these beings, Ehrenberg has distinguished eight muscles by name, and disclosed numerous additional facts of great value.

In their generative system he has proved the existence of all three modes of generation; the viviparous, the oviparous, and the gemmiparous. Some species of the animals are hermaphrodite. Besides clearly demonstrating these three systems, the digestive, the muscular, and the generative, to exist in these minute beings, Ehrenberg conceives that he also discovers in them a vascular and a nervous system: but the two latter are not considered as yet clearly demonstrated.

Dr. Ehrenberg has formed a classification of them according to their organization. The geographical distribution of these beings is replete with interest. He has prosecuted his researches in extensive journeys in Africa and Arabia, and in Russia, Siberia, and the Altaï mountains; and he has discovered species in the subterranean waters of the silver mines of those mountains, at the depth of fifty-six fathoms.

This subject derives increased interest, in London, from the daily exhibition of Messrs. Carey and Gould, in Bond-street, by the light of a pea of lime heated by the oxy-hydrogen blowpipe.

ANIMAL LIFE. Life, in the earlier periods of natural history, was attributed only to animals. With the progress of science, however, it was extended to plants; and man, who had been hitherto regarded as a distinct order of being, is now considered as but a higher animal, intimately connected with the whole chain of the organized world. The great discoveries in chemistry, electricity and galvanism, have shown that those elements and principles, on which rest the laws of life, pervade nature in the most various forms and combinations; that there is no abrupt distinction between the animate world and the inaminate, but, on the contrary, an intimate connexion between the energy which makes the crystallizing mineral follow the law of the strictest regularity, or the stone fall to the ground, and that which makes the heart of man beat. The gradations, too, are so minute that minerals advance into vegetation, and vegetation into animal life; and naturalists, in consequence, find it impossible to decide where either of the three kingdoms of nature begin or end.

Lamarck lays down the nine following characteristics, as common to all animals, and peculiar to them, and constituting, therefore, the distinction between the animal and vegetable kingdoms:

1, That they have parts susceptible of contraction of themselves, and thus the power of moving themselves suddenly and repeatedly.

2, That they have the power of changing place, and of acting at will, if not completely, at least to a great extent.

3, That they perform no motion, total or partial, unless in consequence of certain motives, and that they are able to repeat the motion as often as the exciting cause operates.

4, That they betray no perceptible relation between the motions they perform and the exciting cause.

5, That their solid as well as fluid parts partake of the vital motions.

6, That they nourish themselves with compound substances of a different nature from themselves, and that they digest these substances in order to assimilate them.

7, That they differ from each other in their organization, and in the faculties resulting from this organization, from the most simple to the most complicated, so that their parts cannot be mutually transformed into each other.

8, That they are able to act for their own preservation.

9, That they have no predominant tendency in the developement of their bodies to grow perpendicularly to the plane of the horizon, or to preserve a parallel direction in the vessels which contain their fluids.

Cuvier's system is as follows: First Class, *Vertebral animals*. They have an internal skeleton, composed of a series of bones attached to each other, and called the *vertebral column*. It is perforated by a canal containing the substance from which the nerves, or organs of sensation, take their rise. This column is terminated at one end by the head, (which is, perhaps, only a vertebra fully developed,) and at the other by the *os coccygis*, or tail. Two cavities, the chest and the abdomen, contain the principal organs of life. The sexes are two, male and female; testicles belong to the former, ovaries to the latter; a spleen, liver, pancreas, jaws incumbent, transversal, and provided with teeth (which are imperfectly developed in the beak of birds,) not more than four limbs, constitute the character of this class.

I. *Mammalia*; producing their young alive, which they suckle by teats; having warm blood; a heart with two ventricles; lungs; a convoluted brain, with a *corpus callosum*; five senses; a muscular diaphragm between the chest and the abdominal cavity; seven cervical vertebræ (one species excepted, which has nine.) The *mammalia*, among which man is included, are generally the most intelligent of animals; they are divided into orders, according to the structure of their teeth and their feet, which organs determine the habits and manner of life in animals.

II. *Birds, aves*; oviparous; the eggs covered with a calcareous shell; without milk or teats; heart and blood like those of the *mammalia*; lungs; no diaphragm; no teeth apparent on the jaws, which are called the *beak*; feathers and wings; projecting sternum, which completes the apparatus for flying; a gizzard for a stomach; no external ear. These animals are the only ones which sleep standing; they are divided into orders, according to the structure of the beak and feet.

III. *Reptiles*; oviparous; the eggs without shells, and sometimes fecundated without coition; single heart;

blood almost cold, and red. The reptiles indisputably form a separate class, but they have few common characters peculiar to them; some are enclosed in a bony shell; others are naked; and others are covered with plates, scales, or rings. There are some which have limbs; others, without the least trace of them; and others, in which the number and structure of the limbs vary. Some undergo transformations, like insects, and are, at one period of their life, real fish, and for the rest of their days, little quadrupeds.

IV. *Pisces*, fish; oviparous; eggs without shell or albuminous envelope, and fecundated without coition; single heart; blood cold and red; no real limbs, their place being supplied by vertical fins: this vertical disposition of the fins is sufficient to distinguish, at the first glance, fishes from the cetaceous animals, which have horizontal fins; the body is naked, when not covered with scales; the skeleton is destitute of solidity, and, in the lower species, is reduced to a mere cartilaginous vertebral column.

Second Class. *Mollusca*; have no skeleton; the muscles attached to a soft skin, which is sometimes naked, and sometimes covered with shells of very various forms. The nervous system, in these animals, is confounded with the other parts; none of the organs is protected by a bony case; the nervous system is composed of several *ganglia*, a sort of little brain, connected by sensitive filaments. The organs of nutrition and generation are very complicated in some; they appear to have but two senses, touch and taste, but some have also sight; they breathe by gills, and sometimes have three hearts. Cuvier divides the *molluscæ* into six orders: the *cephalopoda*, *pteropoda*, *gasteropoda*, *acephala*, *branchiopoda*, and *cirrhopoda*.

Third Class. *Articulated.* Their nervous system is composed of two long cords, running the whole length of the body, interrupted, at intervals, by knots, or *ganglia*, the first of which is always the largest; the blood is cold, generally a white lymph, except in the first order, the *annelides*, in which it is red. The body and limbs, when they have any, are composed of rings. This great division will probably undergo some modifications hereafter. 1. *Annelides;* heart fleshy, visible; blood red; breathe by gills, the position of which is various; body composed of articulated rings; no feet, sometimes thread-like members in their stead. The *annelides* are hermaphrodites, and probably oviparous. 2. *Crustaceous;* heart composed of one fleshy ventricle; blood white, circulates; breathe by gills; provided with antennæ, commonly with four, and several transverse jaws; they are oviparous, and the sexes are distinct. 3. *Arachnides*, spiders; head and thorax united; no antennæ, nor gills; breathing by tracheæ, or by pulmonary bags; distinct sexes; eggs; the young undergo no complete transformation after they are hatched; number of eyes and feet variable. 4. *Insects;* no heart; lymph instead of blood; breathe by tracheæ; body divided into three important parts,—the head, which supports the antennæ, and compound eyes, consisting of numerous facets; the thorax, to which are attached the feet, to the number of six, and the wings, to the number of four or two; finally, the abdomen, containing the principal viscera: sexes distinct; oviparous; generate by copulation; the young undergo wonderful transformations. Insects propagate but once during their life. They are divided into orders, according to the structure of their mouth, of the tarsus or foot, of the antennæ, and of the wings.

Fourth Class. *Radiated.* This class is distinguished from the three preceding almost entirely by negative characters, the animals included in it having few characters in common. They all inhabit the water. 1. *Echinodermata;* distinct organs of respiration and circulation; the viscera contained in an interior cavity, formed by the spines disposed in rays, and sometimes star-formed; they inhabit the sea. 2. *Intestini*, intestinal worms; long body, without limbs; no distinct viscera, except a long digestive canal; parasites of other animals, in whose bodies they are found; it is not known how they enter them, nor is any thing known of their manner of respiration and generation. 3. *Acalephæ*, sea-nettles; body orbicular or radiated, containing a digestive sack; no organs of circulation, respiration, or generation distinguishable; some of them, however, emit a substance, which might be taken for eggs, and which, when touched, excites a tingling sensation in the skin, similar to that produced by nettles; the mouth serves as an anus. They inhabit the sea. 4. *Polypi;* body soft, contractible, forming an intestinal sack, which presents the appearance of an orifice, surrounded by tentacula; no appearance of organization which would lead us to suppose them endowed with any sense except that of touch. They are found only in the water, but inhabit both salt and fresh. 5. *Infusoria;* bodies transparent, contractible, microscopic; and abound in organs, often as complicated as those of the largest animals.

Animal Heat, is that property of all animals, by means of which they preserve a certain temperature, which is quite independent of that of the medium by which they are surrounded, and appears rather to be in proportion to the degree of sensibility and irritability possessed by them. It is greatest in birds. The more free and independent the animal is, the more uniform is its temperature. On this account, the human species preserves a temperature nearly equal, about 96-100° Fah., in the frozen regions at the pole, and beneath the equator; and on this account, too, the heat of the human body remains the same when exposed to the most extreme degrees of temperature; in fact, cold at first rather elevates, and extreme heat rather depresses the temperature of the human body. Fordyce and Blagden endured the temperature of an oven heated almost to redness, and two girls in France entered a baker's oven heated to 269° Fahr., in which fruits were soon dried up, and water boiled. A Spaniard, Francisco Martinez by name, exhibited himself, a short time since, at Paris, in a stove heated to 279° of Fah., and threw himself, immediately after, into cold water. Blagden was exposed in an oven to a heat of 257°, in which water boiled, though covered with oil. There is also a remarkable instance of a similar endurance of heat by the *convulsionnaires*, as they were called, upon the grave of St. Medardus, in France. A certificate, signed by several eye-witnesses, among whom were Armand, Arouet, the brother of Voltaire, and a Protestant nobleman from Perth, state that a woman named La Sonet, surnamed the *salamander*, lay upon a fire nine minutes at a time, which was repeated four times within two hours, making, in all, 36 minutes, during which time fifteen sticks of wood were consumed. The correctness of the fact stated is allowed, even by those opposed to the abuses in which it originated.

Animal Economy. It is necessary to entertain sound general views of the fundamental principles of animal life, before we can reason on particulars. The Editor considers animalization as commencing in the simplest mechanical structures, almost as a viscid bubble, which expires by the gravity of its atoms; and he then proceeds to the bubble, or hydatid, which, by local circulation and absorption, counteracts gravity, and maintains its entity. The intermediate steps are vast and circuitous. They proceed from mineralization through vegetation, and the acmè of all these forms is the bubble which exists without roots in the ground, which absorbs, and secretes, and displays general irritability. Such a bubble, then, is the primary study of the physiologist, for it is itself a vast step and the true basis of all animalization. We trace it in the progressive forms of the polypus, and at length find this creature endowed with arms and adjuncts of absorption and elimination, which, expanded and varied, are, in a word, the whole animal kingdom. This fundamental being is a stomach, whose powers are the same in the simple hydatid, and all the rest; the bones, the muscles, the nerves, the circulatory system, the respiring system, &c. &c. being to be considered as adjuncts for the supply and support of the stomach. An equal analogy prevails in the parts of fructification and procreation; and he who would be wise, as to the most complicated forms, must condescend to commence his enquiries with the simplest forms which nature presents. The analogies are true, certain, and unequivocal, and when anomalous, are variations upon variations. Animal life must, therefore, be regarded as originating and continuing in the stomach; and to this consideration all practices in health and disease must be subservient. Nature's step was from a fixed vegetable, with roots in the ground, to a fixed animal, and then to an organization with roots within itself, to which soil and food was to be supplied, absorbed as far as fit, and expelled as far as unfit. The first creation is strictly that of the stomach, the primitive hydatid or polypus; but the spark of life, like that of a candle, is maintained by the gaseous energies in which the animal is placed, and which are brought to bear by the assimilating powers of the lungs, and sustained by the absorption of substances by the lymphatics. To this last object, the supply, the limbs, nerves, brain, &c. &c. are simply auxiliary, and must be so considered in all our practices. The senses, the sight, the taste, smell, &c. &c. are powers of discrimination for the use, and not the abuse of the stomach. The first consideration is what it will absorb for health and vigour, and not what excites the most, or what best pleases its providitors, the senses. Particular substances may effect secretions, and reach certain diseased organs, but true wisdom lies in so choosing diet that nature may have its course without factitious means of reproducing order in the system. The rule of life ought to be to adopt nature's own preparations in the simplest forms. The general order seems to be, 1. Matter. 2. Motion. 3. Gassification. 4. Mineralization. 5. Vegetation. 6. Animalization; that is, matter and motion generate all gaseous forms, and these mineral organization. On these subsist vegetables, and vegetables seem to be the preparers of mineral substances for various animal existence. Man sophisticates and lives so much out of nature, that he is unable to discriminate even his own natural food, but he may, in this respect, take safe lessons from those who, reasoning less, err and sophisticate less. The horse takes no alcohol, yet how strong he is! he takes no spices, or medicated preparations, yet, in his native fields, how healthy, lively, and vigourous. We must, therefore, take lessons from nature, and look back and around us. We are wise, but it is the wisdom of nomenclature and we perplex ourselves by looking at the complex and elevated, instead of the simple germs of our being.

Animal Matter, is the protection, the residence and the visible form of animal life. The simple elementary substances are combined with the powers of life, according to the objects for which it was destined, into various animal substances, falling naturally under certain divisions, which all, however, in some respects, comprehend each other. These divisions are as follow:

*Fluids*. These have no distinct form or organization, and yet possess properties, by means of which, when acted upon by the vital powers, they are capable of forming all the various organs of the body; and it is surely a most unnatural view of them to regard them as destitute of motion. In the following list of animal fluids, which, in the processes of life, pass constantly the one into the other, we find all the fluid parts or kinds of animal matter: they are chyme, chyle, lymph, venous and arterial blood, and the various secreted and excreted fluids.

*Solids*. These comprehend all the solid parts of the animal frame, both hard and soft, and are of nearly the same essential structure in all animals, although variously arranged, according to their species. They appear in the form of, 1, bones, constituting the basis, the frame, of the animal, and found in all animals till we come to shell-fish (whose shells may be even regarded as external bones), and to still inferior animals, possessing no substitute for bones; 2, ligaments and fibrous membranes, connecting and covering them; 3, muscles, which move them, and place the body and its limbs at the command of the animal; 4, fat and marrow, which soften and lubricate all the various parts of the body; 5, nervous or medullary matter, constituting the brain and nerves, in which the total power seems more particularly to reside; 6, the cellular substance, or membrane, which pervades all parts of the frame, and serves to connect them, and to furnish with the fat, which fills its cells, a soft bed for the vessels, nerves, &c.; 7, the mucous membranes, lining the whole body, from the nose and mouth to the parts at which all evacuations take place, and thus coating the mouth, throat, lungs, stomach, and bowels, in which the important functions of digestion and respiration are performed; 8, the serous membranes, which line all the large cavities, and which, by the soft fluid that always moistens their surface, render easy the motion of all the internal organs upon each other; 9, the vascular system, or vessels of all descriptions, conveying the blood to all the organs of the body, and returning it from them to the heart and lungs; and, 10, the glandular system, by means of which various fluids important to life are separated from the blood, or rather formed from it by a new composition of its original elements.

These classes of animal matter comprehend all the forms, in which it appears in animals of all kinds; the heart of a frog and of a philosopher being composed of similar muscular fibres, and their brains of similar nervous matter.

These obvious component parts of animals are, however, separable by the art of the chemist into more simple and ultimate elements. The following are all that are at present known to exist, and of these some are peculiar to animals. They are, 1, iron, which is found chiefly in the blood, in the state of an oxide; 2, lime, which enters largely into the composition of bones, shells, &c.; 3, silex, in the enamel of the teeth; 4, water, which gives their liquid character to all the animal fluids; 5, air is found, mixed with watery vapour, in the various cavities of the body; 6, soda, united with various acids, in all the various fluids of the body; 7, ammonia, in the sweat, urine, &c.; 8, sulphur; 9, phosphorus, in the bones, &c.; 10, carbon; 11, various acids, as the phosphoric, muriatic, uric, lactic, formic, &c., which are found, variously combined, in most of the solid and fluid parts of the body; 12, gelatin, or glue; 13, albumen, constituting the chief part of the transparent and colourless membranes, and the fluids which moisten them; 14, fibrine, constituting the basis of all the muscles, ligaments, &c., and the most important ingredient in the composition of the blood.

Most of these substances are again susceptible of still further analysis, by which they may be resolved into the simple gases, as nitrogen, hydrogen, oxygen, &c.; so that it appears, that the ultimate elements of all parts of the visible world have nearly the same essential character.

ANISE Seeds are cephalic, stomachic, carminative, diuretic, and emmenagogue. They are imported from Alicant, and extensively used.

Anise, Star, (*anisum stellatum*).

Seeds are fine scented, stomachic, and make excellent liqueurs. They are also burnt as incense, and yield an essential oil.

ANISEED CORDIAL is made by mixing with 7 galls. of spirits (1 in 6,) $\frac{1}{4}$ pint of strong spirits of wine, $\frac{3}{4}$ oz. of oil of aniseed, with 3 galls. of water; in which dissolve 3 lbs. of loaf sugar and 1 oz. of powdered alum.

ANISEED OIL is used as a carminative, and half a pound of oil is produced by the distillation of 30 lbs. of macerated seeds with water enough to cover them.

ANISEED, SPIRIT OF, is made by macerating, for 24 hours, half a pound of bruised aniseeds, with a gallon of proof spirit, and slowly distil with water, to prevent burning.

ANISEED WATER is a distillation, with rectified spirit, from the Spanish seed of the Pimpinella Anisum.

ANNEALING, or NEALING, as it is called by the workmen, is a process particularly employed in the glass-houses, and consists in putting the glass vessels, as soon as they are formed, and while they are yet hot, into a furnace or oven, not so hot as to remelt them, in which they are suffered to cool gradually. This is found to prevent their breaking so easily as they otherwise would, particularly on exposure to heat. Unannealed glass, when broken, often flies into powder, with great violence, and, in general, it is in more danger of breaking from a very slight stroke than from one of considerable force. An unannealed glass vessel will often resist the effect of a pistol-bullet dropped into it; yet a grain of sand, falling into it, will make it burst into small fragments, and, which is very curious, it will often not burst until several minutes after being struck. A similar process is used for rendering cast-iron vessels less brittle.

Most of the malleable metals have two distinct structures, one the crystalline, which they assume by slow cooling; and the other, the fibrous, acquired by hammering or rolling. Malleable metals in the ingot or cast state are brittle, and exhibit a crystalline fracture, but by hammeriug or rolling, they become tenacious, break with difficulty, and exhibit a fibrous fracture. They become stiffer and more elastic, but they lose the elasticity by annealing, and become more malleable. If the annealing be long continued, the malleability diminishes, and they again acquire a crystalline fracture. Zinc by drawing into wire becomes very flexible, and with tenacity like copper. But, if it be kept in boiling water, zinc resumes its brittleness, and shows a crystalline structure when broken. So brass-wire loses its tenacity by exposure to the fumes of acids, or even to a damp atmosphere.

ANNOTTO, EGG, is made by steeping the seeds of *Bixa orellana* in water for seven or eight days, stirring the liquid passing it throw a sieve, and boiling it; when the colouring matter is scummed off, and made up while soft with oil into cakes. It is used chiefly in dyeing.

ANNOTTO ROLL is made by rubbing the seeds with the hands, previously dipped in oil, till the red pellicles come off, and are reduced into a clear paste, which is scraped off and dried in the shade. It is used by females as a paint.

ANODYNE, means for soothing pain. A pain may be produced by inflammation; and, in this case, cooling means, lukewarm poultices, sometimes even bleeding or purging, will be the proper anodynes. At other times they should be of an inflammatory kind; for instance, in debility of the nerves, cramps, or spasms. In the stricter sense, we understand by anodynes such remedies as lessen the susceptibility to painful impressions, by diminishing the sensibility of the nerves. As this property exists to a high degree in opium, it not only obtains the first place in this class of simples, but the name *anodyne* is given to all mixtures containing it.

ANODYNE NECKLACES are roots of henbane strung in the form of beads, with the superstitious belief that they assist the cutting of teeth.

ANTHRACITE, is the name of one of the most valuable kinds of coal. Its mineralogical character is as follows: color grayish-black, or iron-black; lustre, imperfectly metallic; opaque; specific gravity, from 1·4 to 1·6; fracture conchoidal. Some varieties abound in fissures, in consequence of which they possess an irregular columnar structure, and a lower degree of lustre; while others are highly compact, of a black color, with a shining lustre, and occasionally highly irradiated with iridescent colors. Anthracite consists wholly of carbon, mixed with a slight and variable proportion of oxide of iron, silex, and alumine. It is inflammable with some difficulty, but burns without smell or smoke, leaving an earthy residue. It is less widely distributed than bituminous coal, and belongs exclusively to transition rocks. It has been found in Wales, at Kilkenny, Walsal, and in Scotland.

In the United States it occurs in great abundance, and, within the last ten years, has acquired a high degree of importance. Its difficult combustibility was, for a time, an obstacle to its introduction; this, however, was obviated by the invention of peculiar furnaces and grates. It is now largely used in all the maritime parts of the United States, not only for manufacturing purposes, in which its utility is immense, but in the warming of apartments, both private and public; and its cheapness, the intensity and equability of heat it produces, together with its perfect safety, and freedom from all disagreeable smoke and smell, give it a decided preference over every other species of fuel.

In Pennsylvania, the anthracite coal formation is known to cover a tract of country many miles in width, extending across two entire counties. It has afforded the chief supply of coal from this region, as well as the greater proportion consumed in the United States. At Mauch Chunk, 800 men were employed in digging this coal, in 1825, and 750,000 bushels were sent to Philadelphia. The anthracite, throughout this region, is explored with very little labour, being situated in hills from 300 to 600 feet above the level of neighbouring rivers and canals, and existing in nearly horizontal beds, from 15 to 40 feet in thickness, covered only by a few feet of gravelly loam. At Portsmouth, in Rhode Island, an extensive bed of this coal has been worked, with some interruption, for 20 years; and, more recently, a mine of anthracite has been opened in Massachusetts.

Vast quantities of this mineral may be found in Great Britain. In no part of the world is it so valuable in the arts and for economical purposes, found so abundantly as in Pennsylvania. For the manufacture of iron this fuel is peculiarly advantageous, as it contains little sulphur or other injurious ingredients; produces an intense steady heat; and, for most operations, it is equal, if not superior, to coke. Bar-iron, anchors, chains, steam-boat machinery, and wrought iron of every description, have more tenacity and malleability, with less waste of metal, when fabricated by anthracite, than by the aid of bituminous coal or charcoal, with a diminution of 50 per cent. in the expense of labour and fuel. For breweries, distilleries, and the raising of steam, anthracite coal is decidedly preferable to other fuel, the heat being more steady and manageable, and the boilers less corroded by sulphureous acid, while no bad effects are produced by smoke and bitumen.

ANTI-LITHICS, are an important class of remedies to prevent secretions of gravel, and the formation of stone. 1000 parts of urine appear to consist of 933 of water, 30 of the acid called urea, 18 of animal products, and the other 19 of various salts. In disease it contains several other substances. The smell and colour arise from lactic acid. One part of lithic acid, the bases of gravel and stone, arises from nitrogen, derived from animal food and fermented liquors.—Calculi have eight different characters, but in two-thirds their base is lithic acid. Lime-water and abstinence from animal food and ferments are prescribed as the remedy. The famous remedy of Mrs. Stephens consisted of calcined egg-shells, made into pills with soap. She also gave a decoction of chamomile, fennel, parsley, and burdock with Alicant soap. Others advise an ounce of salt of tartar in a pint of parsley-water. But alkalis in general are considered as the efficient remedies.

ANTIMONY, is a bluish-white, brittle metal, of a scaly or foliated texture; it has a brilliant lustre, but becomes tarnished by exposure to the air; its specific gravity is 6·7. In this state, it is called the *regulus of antimony*, and is used as an ingredient in the manufacture of the best pewter, in some type-metal, and in casting leaden medallions. By exposure to heat it melts, and, becoming oxydized, rises in dense white fumes, formerly called *argentine flowers of antimony*.

Antimony forms with oxygen several oxydes, with which the acids unite and give rise to numerous salts, the most important of which is the triple one, called *tartrate of potash and antimony*. It is manufactured in the large way by mixing one pound of glass of antimony with a pound of cream of tartar, and boiling the mixture in a gallon of water for an hour or two. It is then filtered, evaporated, and set by to crystallize. Tartar emetic is the most generally used in antimonial medicine; and it may be so managed as to produce either sweating, purging, or vomiting.

Antimony is found in its metallic state in minute quantities in several countries, and in occasional mixture with ores of silver, lead, and copper; but it is from its combination with sulphur, in which state it occurs abundantly in Auvergne, Scotland, and Hungary, that the antimony of commerce is furnished.

This mineral, the sulphuret of antimony, is found in compact, foliated, and radiated masses, as well as in distinct rhombic prisms. Its color is a light lead-gray; it is dull, and often irridescent. Specific gravity 4·3. It melts in the flame of a candle, and before the blow-pipe, on charcoal, is wholly evaporated, with a sulphureous odour.—It is composed of antimony 72·86, and sulphur 27·14, and in its composition exactly resembles the artificial compound which possesses the same properties. To obtain the crude antimony of commerce, the above ore is reduced to fragments, and put into large earthen pots, with holes in their bottoms, and these are inserted into other similar vessels; heat is applied to the upper ones, which causes the sulphuret of antimony to separate from its stony gangue, and flow into lower vessels, which are kept cold; here it concretes into fibrous, crystalline masses, without having undergone any change. From this the regulus of antimony is prepared, by roasting the sulphuret of antimony in a reverberatory furnace, until it forms a gray oxyde, 100 weight of which is afterwards mixed with 8 or 10 pounds of argal, or crude tartar, and smelted in large melting pots in a wind-furnace. It also affords, by calcination and subsequent fusion in earthen crucibles, the glass of antimony, which is of so much importance in the preparation of tartar emetic.

The Kermes mineral, a popular medicine, is likewise prepared from the sulphuret of antimony. By boiling crude antimony and pearlashes, the Kermes mineral is deposited in the form of a purplish-brown powder. The supernatant liquid, on the addition of any acid, yields an orange sediment, called *golden sulphur of antimony*, which is used by calico-printers as yellow color.

Our antimony is brought chiefly from the Eastern Archipelago, though it is produced in the Hartz Forest, and in the mines of Cornwall.

Antimony is very useful physic for horses and pigs. It cures running heels, and makes them fat, if a dram is given with their oats every morning. It cures diseases in pigs, and also fattens them. The alchemists Valentine and Paracelsus considered it the universal medicine.

The *Sulphuret of Antimony* is officinal. It is a deep gray with a specific gravity, 4·368, $1 S + 1 A = 60$. It is employed in scrofula and rheumatic gout, and by decomposing acid is gently cathartic. It is found native, and pounded and levigated for use. It is sometimes precipitated, by boiling with twice its weight of solution of potass, and as much distilled water, and adding while hot some sulphuric acid, and then washing away the potass.

The *Tartar Emetic*, or tartrate of antimony, is prepared by triturating seperately equal weights of sulphuret of antimony and nitrate of potass. Mix the powders and put them in a red-hot crucible till reduced to red matter and white crystals, which last reject, and triturate, and wash and dry the red part. Then rub it with an equal weight of super-tartrate of potass, boil it in 4 times the weight of pure water for an hour; strain it through paper, and leave it to form crystals.

Or, it is made from 4 parts of the nitro-muriate as above, and 5 of bitartrate of potass, which are to be mixed and added by degrees to 34 parts of boiling water. In half an hour filter through paper and leave to crystallize. This is a valuable emetic and diaphoretic, prescribed also in inflammations, pleurisy, and apoplexy. With calomel it is an alterative. One, two, or four grains is a dose. In large doses it operates as a poison by corrosion. A scruple boiled in 8 fl. oz. of water, and 2 of spirit added, or filtering, is the solution of *tartar emetic*.

If a globule of *Antimony* is heated by the blow-pipe and candle, and dropped 5 or 6 feet on paper, or thrown against a wall, the combustion is very brilliant, proving the great quantity of hydrogen which it contains.

*Butter of Antimony.* Take common antimony and corrosive sublimate, equal weights, grind together and distil in a wide-necked retort, and let the unctuous matter that comes overrun in a moist place to a liquid oil, or antimony calcined to greyness; or, take powdered glass of antimony 9 oz., salt 32 oz., oil of vitriol 24 oz., water 16 oz., and distil for 40 oz. of butter of antimony; or, take common antimony, or glass of antimony 1 lb., salt 4 lbs., sulphuric acid 3 lbs., water 2 lbs., and distil.

*Antimonium Tartarizatum.* Take crocus of antimony 3 lbs., cream of tartar 4 lbs., water 4 galls.; or, glass of antimony, cream of tartar, each 1 lb., water 1 gallon; boil, filter, and crystallize. It is emetic, in doses 1 to 4 gr. An alterative and diaphoretic, in very small doses, as 1-16th to 1-4th of a grain.

*Flowers of Antimony*, or prot-oxide, is made by mixing muriate of ammonia in water, and washing the precipitate with a weak solution of potass, and then with water and drying it. Nitric acid renders it a *peroxide*.

*Glass of Antimony* is the sulphuret roasted and stirred so as to exhale the sulphur, and then melted and vitrified with intense heat.

*Algaroth Powder* is made by throwing the butter of antimony into water, and the precipitate is the powder of algaroth.

*Antimonial Wine.* In a pint of sherry dissolve 24 grains of emetic tartar, (the tartrate of potass and antimony.) In a dose of half a dram, to a dram and a half, it is alterative; in one of half an ounce to an ounce, it is emetic.

*Liver of Antimony* is made by roasting common antimony to a dull grey, and melting it.

*Crocus metallorum* is common antimony and saltpetre, in equal weights; mixed and melted.

The *Nitro-muriate of Antimony* is prepared by digesting and boiling 1 sulphuret of antimony with 5 muriatic acid, and 0·05 nitric acid. Strain it, pour it into water, and wash away the acid. Dry it on paper for use.

*Antimonial Powder* is made by mixing 1 part of the sulphuret with 2 parts of hartshorn shavings, and stirring them in an iron vessel at a white heat till the fumes cease. The residue is then to be powdered and exposed in a crucible at a white heat for 2 hours; and afterwards triturated. It is a valuable medicine as a diaphoritic, emetic, and purgative, and the basis of James's powders. Antimonial powder, consisting of 43 phosphate of lime, and 57 oxide of antimony, is the college substitute for James's powder. Dr. Paris, in his valuable *Pharmacologia*, says the difference is inconsiderable.

ANTISEPTICS; remedies against putrefaction. We are indebted to chemistry for most of these remedies, which generally operate by absorbing the liquids and gases of gangrenous parts. Among antiseptical substances, charcoal-powder has hitherto been one of the most esteemed, but the chloride of lime has been recently discovered to be much more efficacious in arresting the progress of putrefaction. Placed in contact with the affected parts, it destroys the offensive odour which they exhale, and prevents the extension of the corruption. But the practitioner must adapt the treatment to particular circumstances: to inflammation he opposes bleeding, emollients, &c.; to weakness, nourishing food, tonics, &c.: at the same time administering the local application of the antiseptic.

The medicines which arrest putrefaction are, bark and bitters; acids; wine and alcohol, or camphor, assafœtida, &c.

ANTISPASMODICS, are medicines which relieve cramps and convulsions, as sal volatile, ether, alcohol, laudanum, camphor, musk, assafœtida, &c. Opium, balsam of Peru, and the essential oils of many vegetables, are the most useful of this class of medicines.

Antispasmodic Mixtures. Musk, gum arabic, and fine sugar, each 1 dr., rose-water 6 oz.; 1 oz. 5 or 6 times a day. Or, tincture of castor 1 dr., sulphur of ether 10 drops, tincture of opium 7 drops, and cinnamon water $1\frac{1}{2}$ oz., making 1 dose to be repeated 3 times in the day. Or 2 dr. of assafœtida in a pint of water.

ANVIL, is the important block of smiths, generally fitted with a spike or horn, with the iron so hard that a file cannot touch it.

The common smith's anvil is generally made of seven pieces, namely, the core or body; the four corners, for the purpose of enlarging its base; the projecting end, which contains a square hole, for the reception of a set or chisel, to cut off pieces of iron; and the seventh piece is the beak, or conical end, used for turning pieces of iron into a circular form, welding hoops, &c. These pieces are each separately welded to the core, and hammered so as to form a regular surface with the whole. When large pieces are required to be welded to the core, one fire is not sufficient to heat both at the same time. In this case, two hearths are employed. The core and the piece are both raised to a welding heat. The piece being put into its place, is hammered by a quick succession of blows, till it adheres. The whole is again heated and hammered till the due form is obtained. The hammering is performed by a number of men at the same time, each using a large swing-hammer. The blows follow each other in regular succession; great experience and care being required to prevent the hammers from coming in contact with each other.—*Ency. Brit.*

APOPLEXY, is the name of a disease which occurs very suddenly, as if a blow had been inflicted upon the head, which deprives the person of consciousness and voluntary motion, while the respiration and action of the heart continue, although much oppressed. In a complete apoplexy, the person falls suddenly, is unable to move his limbs or to speak, gives no proof of seeing, hearing, or feeling, and the breathing like that of a person in deep sleep. Consciousness sometimes remains in part; some power of motion is retained in one, or in some parts, at least; the speech is not entirely lost, but is only an unintelligible muttering of incoherent words.

The immediate cause of this disease is some affection or injury of the brain, or of some portion of it; and it is most commonly produced by a fulness of blood in the head, either remaining in the blood-vessels, or poured out, in or upon the brain, from their rupture in some part, and in sufficient quantity to exert considerable pressure upon that organ. The disposition to it is sometimes hereditary, and is most usually found to accompany a short, full person, a short neck, and a system disposed to a too copious sanguification. It sometimes, also, occurs in people who are exhausted by old age, excessive labour or anxiety, and, in these cases, the brain seems to be too weak to perform its common functions.

Although an attack of apoplexy comes on, for the most part, suddenly and unexpectedly, yet it is often preceded by appearances which give warning of its approach. These are a high colour of the whole face, giddiness or vertigo, sparks or flashes of light before the eyes, noises in the ears, bleeding at the nose, and pain in the head. The danger, in such cases, may most commonly be averted by bleeding and abstemious diet, to be continued till these symptoms are removed. When a person is unfortunately attacked by apoplexy, the first step should be to open the cravat and collar, so as to leave the neck free: if it be a short time after a meal, or if the last meal has been of an indigestible character, the stomach should be emptied by an emetic, or by tickling the throat with the finger, without waiting for a physician, and, at the same time, a vein or two should be opened, so as to produce a free flow of blood.

APOTHECARIES' HALL, London, is the most perfect medico-chemical laboratory in the world; and it has now for some years possessed, in various branches of pharmacy, the ablest professors of the age, to direct and to improve the wholesale preparations of its medicines. No institution ever deserved more public confidence, and for once public feeling and great merit are in accordance. By its examinations and certificates, too, it has raised the compounder of drugs into scientific rank, and has delivered the public from the avarice and ignorance of quacks, who, in every generation, have been used to destroy even more than have fallen victims to the ambition of kings, and the follies and crimes of courts and statesmen.

APOTHECARIES, measure, is by the imperial gallon of 10 lbs. of pure water, at 7000 grains to the lb. or 277·274 cubic inches; but they weigh by their, or the troy, pound, of 5760 grains, and divide the lb. into 12 ounces, of 480 grains each; each ounce into 8 drachms, of 60 grains; and each drachm into 3 scruples, of 20 grains; so that in a lb. there are 12 ounces, 96 drachms, and 288 scruples.

The lb. avoirdupois is, to the apothecaries and troy lb. as 7000 grains to 5760, or as 350 to 288.

Every scruple, therefore, is the 350th of a lb. avoirdupois.

Then, as the lb. avoirdupois is divided into 16 ounces, each 437·5 grains, and the apothecaries ounce is 480 grains, ounce by ounce, the latter is the greater by $42\frac{1}{2}$ grains.

And, as the avoirdupois ounce is in 16 drachms, of 27·34375 grains, and the apothecaries drachm is 60 grains, the latter is 31·65 grains greater.

An imperial gallon, 277·274 cubic inches, is contained in a vessel 6·52083 inches in length, breadth, and depth, and is 10 lbs. or 70,000 grs. of pure water.

A quart, the fourth of a gallon, is 69·3185 cubic inches, and 4·10781 inches in each dimension, and $2\frac{1}{2}$ lbs. or 17,500 grains.

A pint, the eighth of a gallon, is 34·65925 cubic inches, or in each dimension 3·2604153 inches, or $1\frac{1}{4}$ lb. or 8750 grains.

Apothecaries designate pounds by ℔, ounces by ℥, drachms by ʒ, scruples by ℈, and grains by *gr*.

They also measure by the gallon, marked C, which is divided into eight pints, marked O, of 16 fluid ounces each. And each fluid ounce, marked f. ℥, into eight fluid drachms, marked f. ʒ; and each drachm into 60 minims, marked ♏.

Hence, there are 8 pints, 128 f. ounces, 1024 f. drachms, and 61,440 minims, in a gallon of 10 lbs. of pure water. And by this fluid measure, a pint weighs 1·25 lbs., a f. ounce weighs 0·078125 of a lb., a f. drachm 0·009765625, and a minim 0·0001627 of a lb.

And a pint of pure water, being 8750 grains, a f. ounce is 547 grains, a f. drachm is $68\frac{3}{8}$ grains, and a minim is 1·14 grains, of which 5760 is the apothecaries lb.

The minim is deemed equivalent to the average drop of which it is considered there are 60 in a fluid drachm, and 6 in about every 7 grains, there being in a fluid pint 7680 minims, or drops, and 8750 grains.

To adjust these minute measures, graduated vessels, for three and four drachms and quarters, are made, and a tube to measure minims. But as 6 minims are 7 grains, and a scruple is 20 grains, a drachm 60 grains, so a scruple is, by weight, nearly 18 minims, and a drachm, by weight, is about 51 minims. Fractions of these weights will, therefore, approximate with accuracy.

These calculations are made on the basis of pure water, but when the liquid is heavier or above 1 sp. gr. then the pint, &c. will be proportionably greater, as, if 1·2, the pint, instead of 8750 grains, will be 10,500 grains. And if 0·9, instead of 1, will 7875 grains, in which case a minim would be a grain exactly; but in the former case it would take three minims to 2 grains.

When apothecaries buy by the lb. they get 175 of their lbs. for 144 avoirdupois; but if they buy by the avoirdupois ounce they get but $437\frac{1}{2}$ grains, while their own ounce is 480, or they pay for 96 oz. while they get but $87\frac{1}{2}$, or 19 nearly for $17\frac{1}{4}$. So in drachms, it is as 60 apothecary's to $27\frac{1}{3}$ avoirdupois, or 2·2 to 1 nearly.

Irregular measures of uncertain content are used in compounding mediums, as, *ss* standing for one half.

A table spoonful of syrup, ℥ss, or ½ oz.
Do. of distilled waters, ʒ iijss to ℥ss, or 3½ drs. to ½ oz.
Do. of spirits and tinctures, ʒ ij to ℥ iij
A dessert spoonful of water, ʒ ij
A tea spoonful of syrup, ʒ j to ʒ ij
Do. of distilled waters, ℈ iss to ℈ ij
Do. of spirit and tinctures, ℈ j to ℈ jss
Do. of a light powder, as maguesia, ℈ ss to ℈ j
Do. of a heavy powder, as sulphur, ℈ jss to ℈ ij
Do. of a metallic oxide, ʒ j to ℈ iiij.
A thimbleful is usually the same as a tea spoonful.
A tea cupful, ℥ iij to ℥ iv.
A wine-glass ful, ℥ jss, 1½ oz.

This subject is treated fully, because important in practice, and because it has been very imperfectly and erroneously treated by mere medical writers, few of whom, as is evident, understand ratios and fractions. Even the able Thompson tells us, that the apothecary's ounce is 487·5 grains instead of 437·5, a serious difference in compounding medicines.

APPLE. This fruit, in all its varieties, is derived from the crab-apple *(pyrus malus,)* which grows wild every where. The uses are various; even the bitter crab-apple has its fermented juice, or *verjuice*, employed in cookery and medicine, and in purifying wax. The wood makes wheel-cogs, &c. Good apples are produced by *grafting*, or inserting young twigs, from trees bearing fine fruit, into inferior stocks. Crab-stocks answer best in England, and the branches of the twig inserted bear fruit corresponding with the tree whence it was cut. The same process is pursued with other fruit-trees, since grafted fruit is the best. The most important application of apples is to cider. The apples should be ground in a mill, allowed to stand a day or two in open vessels, and then they are to be pressed between hair-cloths. The liquor is kept in a vat till it has fermented, when it is drawn off into clean casks, and is to stand till fine and clear. It is afterwards racked, and kept in casks or bottled. Some brandy and flowers of sulphur render it less likely to become sour. A spirit is obtained by distillation from cider, termed cider-brandy, of which great quantities are made in America; while a very strong liquid may be obtained by allowing cider to be frozen, and then drawing off the portion which remains fluid. A far more wholesome liquor than either is *pomona wine*, prepared by adding one gallon of brandy to six of new cider, after it is racked, and this, in eight or twelve months, is a good substitute for wine, and beyond comparison more wholesome than the mixtures under the name of *Lisbon wine*, &c. &c. It is improved by suspending raisins in a net.

There are hundreds of varieties of apples and nearly 100 sorts cultivated. They ripen in succession, and are distinguished into table apples, culinary apples, and cyder apples. For the table the golden rennet, the pearmain, the golden pippin, &c. are preferred; for the kitchen, the codling and the American codling of prodigious size; and for cyder, there are peculiar sorts in Devonshire, Dorsetshire, Somersetshire, and Herefordshire, and similar ones in Normandy, where the roads are wisely lined with bitter cyder apples. The best mode of propagating is by sowing large round seed, thinning, and grafting, on the spot, without transplanting.—*Knight.*

The secret of keeping apples is not to bruise them or handle them, and place them ripe in an equal low temperature. The books abound in methods, and a few are the following:—

*To keep a winter stock of Apples.*—Gather, in a perfectly dry state, when ripe, and lay in heaps on the floor, and in about three weeks wipe with a dry cloth, and every one with the least appearance of speck or bruise lay out for immediate use. They are then to be packed in boxes, thickly lined with thoroughly dried fern, so as not to touch each other, putting a layer of fern and a layer of apples, till the chests are so full as to allow a good thickness of fern at the top. They ought to be again examined after Christmas, and again about April. The building to be very cold, but not at all damp. The greatest difficulty is securing them from frost, which we effect by covering the chests with mats, old carpets, or straw. After a severe frost, the apples ought to be examined. The first inducement to keep them in chests was the building being infested with mice; and the reason for adopting fern, that straw sometimes became mouldy, and imparted a musty sort of flavour to the apples.

*Another Method.*—The fruit-room ought to be in a dry, cold, shady, situation, free from wet, and sunk three feet or four feet in the ground. The shelves should be of beech or sycamore, about two feet wide and ten inches asunder. Fir shelving tastes the fruit. There is no need of fire in fruit-rooms, for a little frost does not injure apples. There ought to be ventilators, as a good deal of air is necessary after the fruit is first gathered and stored. When the apples begin to drop, the ripest are gathered, and taken to the fruit-room in shallow baskets. These are taken singly out of the baskets and placed upon the shelves. After they have been ten or twelve days on the shelves, the process of sweating is accomplished. They are then wiped one by one with clean soft cloths; by this means, a kind of coat or shell is formed, which proves a safeguard to the fruit. The shelves are wiped, at the same time, on both sides, until quite dry. During the whole time the apples are in sweat, plenty of air is admitted, if the weather is clear and dry; but, if damp, the room is entirely shut up. The fruit is turned over about the end of January, and, with the shelves, wiped, if any moisture appears. After this time the room is closely shut up; for the admission of much air, after January, occasions shrivelling. All the time the fruit is in the room it is carefully looked over every four or five days. When apples are frozen, no artificial means must be used to thaw them. If, in sweating, they are affected by frost or damp, they will be materially injured. Apples, laid upon one another in large baskets in a vinery, kept to 60° Fah., for ten days or a fortnight, and then wiped, and conveyed to the fruit-room, and laid on the shelves, have never been in the least impaired.

*Another Method.* Apples preserved in holes in the earth, in the manner of potatoes, were sent to the Horticultural Society on the 14th of February, in as fresh a state as if newly gathered from the tree. The apples should be of hardy and keeping sorts, and not more than four or five bushels should be put into one hole. It is requisite to place straw at the bottom and sides, and also to cover the top of the heap of apples with straw, so as entirely to separate them from the earth.

*Another Method.* Any good baking sort of apple, which is liable to rot, if peeled, and cut into slices about the thickness of one-sixth of an inch, and dried in the sun, or in a slow oven, till sufficiently desiccated, may afterwards be kept in boxes in a dry place, for a considerable time; and only requires to be soaked in water for an hour or two before using.

Apples may be kept the whole year round by being immersed in corn, which receives no injury from their contact.

In Portugal it is customary to have a small ledge in every apartment, (immediately under the cornice), barely wide enough to hold an apple, and in this way the ceilings are fringed with fruit through the winter.

The Scotch mode of preserving apples consists in placing them apart from each other in flat-bottomed earthen jars, with air-tight covers, layers of fine dry sand being put between them, and the jars kept in a cool dry situation.

Apples laid in a large heap in a dry room, being neglected through the winter, perished and rotted on the upper layer, but all beneath were found perfectly sound in the following March.

*To preserve Apples and Pears.*—Wipe the fruit dry, then take a varnished crock, or wide-mouthed jar, at the bottom of which is to be a layer of fine and very dry sand; and on this place a layer of fruit, and alternately fruit and sand until the crock or jar is full. Put a very thick coat of sand on the top, and place it in a dry place all the winter.

*Dried Apples and Pears.*—The apples and pears from France are thus prepared:—The fruit is put into boiling water till it becomes soft. It is then taken out, and peeled, the stalk being left on. When peeled, it is put into an oven, heated as for bread, and left twenty-four hours. When taken out, and cold, it is pressed flat between the hands; and after being plunged into its own juice, it is packed in boxes and exported.

Apple Jelly. Boil down 1 lb. of sugar and 4 lbs. of strained apple-juice.

APPRENTICESHIP. means a contract, by which one skilled in a trade should teach another, and, in return, receive his service, subject, however, to special provisions. Modern economists, who reason on general abstract theories, argue against apprenticeships, connecting them with a prejudice against corporations; but they are necessary to a state of good morals between the age of boyhood and manhood, and the great increase of crime in England may be traced to the doctrinary system of discouraging apprenticeships. The system is also a security to workmen in a trade, whose interests are always entitled to careful protection. If apprentices are made slaves, the fault is in the law or the magistracy, and if not trained to make good men, the fault is in their master, for which the law should also provide. In short, apprenticeship is that education for manhood which properly follows that of the schoolmaster, and both, in succession, make valuable members of society. The consideration ought not to be the time in which a trade can be learnt, but the wholesome restraint from 13 or 14 to 20 or 21; nevertheless, after 20, four years might be a term, and after 25, three years; a regulation which would meet all contingencies.

When a youth in the city of London is bound apprentice, he is presented to the chamberlain, and the following is a copy of Indenture of Apprenticeship:—"This indenture witnesseth, that , son of , late of , doth put himself apprentice to , citizen and of London, to learn his art, and with him (after the manner of an apprentice) to serve from the day of the date hereof, unto the full end and term of seven years, from thence next following to be fully complete and ended; during which term the said apprentice his said master faithfully shall serve, his secrets keep, his lawful commands everywhere gladly do.

"He shall do no damage to his said master, nor see it to be done of others; but that he, to his power, shall let or forthwith give warning to his said master of the same.

"He shall not waste the goods of his said master, nor lend them unlawfully to any. He shall not commit fornication, nor contract matrimony within the said term.

"He shall not play at cards, dice, tables, or any other unlawful games, whereby his said master may have any loss.

"With his own goods or others, during the said term, without licence of his said master, he shall neither buy nor sell.

"He shall not haunt taverns nor playhouses, nor absent himself from his said master's service day or night unlawfully; but in all things, as a faithful apprentice, he shall behave himself towards his said master, and all his, during the said term.

"And the said master, in consideration of , his said apprentice in the same art which he useth, by the best means that he can, shall teach and instruct, or cause to be taught and instructed, finding unto his said apprentice, meat, drink, apparel, lodging, and all other necessaries, according to the custom of the city of London, during the said term.

"And for the true performance of all and every the said covenants and agreements, either of the said parties bindeth himself unto the other by these presents. In witness whereof, the above-named to these indentures, interchangeably have put their hands and seals, the day of , in the year of the reign of our sovereign , of the united kingdom of Great Britain and Ireland, defender of the faith, and in the year of our Lord, &c."

Merchant ships are obliged to have one apprentice for every 100 tons, beginning at 80, and those of 700 and upwards, five; all under 17, and for four years.

APRICOT, is a species of the plum, and there are eight or ten sorts, some of them delicious, and others valuable as preserves. They flourish only in rich dry soils, and should not have the afternoon-sun.

APRIL, *Gardening and Farming in.*—Earth up peas and other drilled crops, as they advance in growth: stick peas before they require such support; it protects and assists their advancement. Continue to sow successions of peas, common beans, cabbage, savoys, celery, spinach, turnips, onions, lettuce, radish of different sorts, &c. according to the size of the garden, regard being had to whether the spot is to be only a seed-bed or the final station of the plant.

Sow the different sorts of brocoli twice in the month, cauliflower once; kidney beans for a first crop, in the last week; also scorzonera, skirrit, and salsify, if required. Finish planting potatoes.

Transplant from the seed-beds lettuce, cauliflower, and any other plants which are capable of and require such treatment. Begin the hoe-culture of killing weeds wherever practicable.

In the orchard, water new planted trees, and put litter round their roots.

Barley crops, not sown in March, should be in the ground by the middle of this month.

There should be two sowings of spring tares this month; one at the beginning, the other at the end. Two bushels and a half per acre.

This is the right season for sowing lucern; sainfoin may also be safely sown.

This month tries *the farmer* more than any in the year.

Pieces of clover and ray-grass grown on land in pretty good heart should succeed as feed for sheep after the turnips; swedes are very useful this month; they should be pulled to prevent their running up to flower, and from becoming fibrous and hard. If pulled, they get mellow, and last, on the ground, good till the end of May. No turnip should be in the ground after March.

Markets for beef and mutton are usually high towards the end of this month. Beasts really fat are sure to sell well at Smithfield.

Do not be anxious to get your cows out of the farm-yard. Swedish turnips and chaff are good food for them. Turning cattle out before there is good bite is unprofitable. They should be well littered both in the yard and house.

The end of this month is the best season for planting potatoes, and for planting the crop of autumn-sown cabbages.

This month must conclude the business of fences; it is bad husbandry to cut hedges after April.

AQUA DISTILLATA, or distilled water, is made in half the first quantity, the first tenth that passes over and the last four-tenths, being to be thrown away. It should then be kept bottled. Rain water, filtered, is the next best. It is a luxury which any one may enjoy, an apparatus costing but a few shillings at any tin-man's, which is capable of distilling a gallon per day, on any fire.

AQUA CARUI, carraway water. A pound of seeds produces a gallon, by distillation with water.

AQUA CINNAMONI, cinnamon water. Macerate for 24 hours, and distil a pound with a pint of water.

AQUA MENTHÆ PIPERITÆ, peppermint water. Two pounds distil a gallon.

AQUA PULEGII, pennyroyal water. Two pounds distil a gallon.

AQUA ROSÆ, rose water. Eight pounds of clean rose-leaves produce a distilled gallon.

To every gallon of these waters, five fluid ounces of proof spirit should be added. The distillation should stop before the substance is burnt. More of fresh plants should be employed than of dried ones.

AQUA REGIA, or nitro-muriatic acid, is one measure of nitric acid and two measures of muriatic acid, mixed and kept cool. It used to be made by dissolving one part of salt in four of nitric acid, or spirit of nitre. It dissolves gold and platinum, and is of a gold colour. Two ounces, in a gallon of water, make a valuable wash for the body, and increase the flow of pile and the action of the intestines.

AQUA REGINÆ, so called as dissolving silver. It is made by pouring 8 or 10 lbs. of sulphuric acid, according to strength, on 1 lb. of refined saltpetre. It is a means of recovering all waste of silver in plating, &c.

AQUA REGIS, (KEIR's) is made by adding a solution of common salt in water to a mixture of sulphuric acid and salt-petre, and it dissolves both gold and platinum, and though formed of colourless fluids becomes on mixture a deep yellow.

AQUA TINTA; the art of engraving on copper, after the manner of Indian ink, by which imitations are made of figures drawn with the pencil, Indian ink, bistre, sepia, &c. particularly those which are on a large scale. There are several sorts of it. In the first, after the outlines of the figure have been etched, finely powdered mastic *(colophonium)* is sifted over the plate, which is then warmed over coals, that the mastic may be melted. In this way, insensible spaces are formed between the particles of mastic, upon which the nitric acid acts. The work then goes on as in mezzotinto, only that the scraper is used; and all the places where there is to be no work or shade, are covered with thick black varnish, on which the acid does not act. Nitric acid is now poured on, and left to stand as long as is necessary for the lightest shade, *i. e.* about five minutes. The light shades are now stopped out with varnish, and the acid allowed to act a second time, and this stopping out is continued till the deepest shades are bit in. In landscapes, in which the trees require more freedom of the pencil, a good etching ground is spread over the plate, and covered by means of a hair-pencil, with oil of lavender, or oil of turpentine, to which lamp-black is sometimes added. The oil softens the ground, which may be wiped off with a fine linen cloth, leaving all the marks made with the pencil apparent on the copper. Then, fine mastic is sifted over the plate, melted in and etched. This operation may be repeated, as there are more or fewer tints in the original.

In France the *roulette* is used—a little wheel or roller of steel, with a rough surface and several prominences, which, when it is rolled back and forth on the plate, deepen the excavations made by the acid. They have roulettes of all degrees of size and fineness, to make deeper or more shallow impressions on the plate. From time to time, the particles separated by this process are removed with a scraper.

The following is the process recommended by Mr. Parkinson:—A resinous substance is dissolved in rectified spirits of wine, as rosin, Burgundy-pitch, or gum mastich, and this solution is poured on the plate, which is then held obliquely till the fluid drains off, leaving the finely-divided particles of the gum on the copper.

Such parts of the design or drawing as are perfectly white, must be stopped-out with diluted turpentine-varnish to a consistence, to work freely with the pencil, and mixed with lamp-black to give it colour. The margin of the plate must also be covered with varnish. When the stopping-out is sufficiently dry, a ridge of wax must be raised round the plate, and nitric acid properly diluted poured on. When the aqua fortis has lain on long enough to produce the lightest tints, it is poured off, and then the lightest tints being stopped out the process is repeated as often as the shades require.

Mr. Parkinson states, that "another very ingenious process has been invented, by which these touches are laid on the plate with the same ease and expedition as they are in a drawing of Indian ink. Fine washed whiting is mixed with a little treacle or sugar, and diluted with water in the pencil, so as to work freely, and this is laid on the plate covered with the aqua tint ground, in the same manner, and on the same parts as ink on the drawing. When this is dry, the whole plate is varnished over with a weak and thin varnish of turpentine, asphaltum, or mastich, and then suffered to dry, when the aqua fortis is poured on. The varnish will immediately break up in the parts where the treacle mixture was laid, and expose all those places to the action of the acid, while the rest of the plate remains secure. The effect of this will be, that all the touches or places where the treacle was used, will be bit-in deeper than the rest, and will have all the precision and firmness of touches in Indian ink."

The spirits of wine used, as in all solutions of gums, must be highly rectified, and free from camphor. Different gums produce different grains. The solution must stand for a day or two, or be filtered through cotton. The room, too, should be quite free from dust, and the plate be perfectly clean. —*See* Etching, &c.

AQUEDUCT; a conveyance of any kind made for conducting water. Some of the immense aqueducts of the Romans are still in use. Others, in the state of ruins, are among the greatest ornaments of Italy. In other ancient countries, also, large aqueducts were built; *e. g.* under Sesostris, in Egypt; under Semiramis, in Babylonia; under Solomon and Hezekiah, among the Israelites. Aqueducts were either formed by erecting one or several rows of arcades across a valley, and making these arcades support one or more level canals; or by piercing through mountains, which would have interrupted the water-course. When the aqueduct was conveyed under the ground, there were openings at about every 240 feet. Some of the Roman aqueducts brought water from the distance of upwards of 60 miles, through rocks and mountains, and over valleys in levels more than 190 feet high. The declivity of the aqueduct, according to Pliny, was 1 inch, and according to Vitruvius, ½ a foot, in a hundred. The principal Roman aqueducts, now remaining, are the *Aqua Virginia*, repaired by pope Paul IV. and the *Aqua Felice*, constructed by Sextus V.

In England, aqueducts are used to convey canals across rivers or valleys, and one is planned by Mr. John Martin to convey pure water to London, instead of the Thames water raised by the water companies.

ARACATSCHA, is the name of a plant of New Grenada, said to be more nourishing and prolific than the potatoe. In flavour and solidity, it resembles the Spanish walnut, and has been cultivated in Germany and England, but not yet brought to market.

ARBITRATION, a method of adjusting disputes, worthy of better arrangement in its forms, but rendered mischievous in the English courts, according to *Gaselee*, by referring to barristers, who decide on precedents of law, and not in accordance with equity and justice. Again, when lawyers are excluded, as they ought to be, the decision is made by a majority of 2 to 1, and therefore wrong once in three times. All decisions, to be generally just, should be unanimous; but as arbitration produces no profit to courts and lawyers, nothing is done in a legislature of lawyers to improve its principle and practices. Half the miseries of life might be obviated by the establishment of a sound system of arbitration, which should secure the equitable decision of questions in dispute, without the purchased sophistry of lawyers, and the chicane of law. It is a proverb among English lawyers, that every suit is a lottery, and "the glorious uncertainty of the law," is a standing toast in the profession.

ARBOR, is the axis of a wheel, spindle, or crane, on which it turns in a machine.

ARBUTUS, a shrub, the powder of whose leaves acts in a very salutary and direct manner on the urinary organs. Its popular name is Trailing Arbutus, and the leaves should be gathered in autumn, dried and powdered. The leaves of the true kind are reticulated, and contain tanning and gallic acid.

ARCH, is a contrivance in building to support superior parts with an opening beneath, necessary for bridges, water-courses, &c. It is a contrivance found in works of masonry before the historic period, and its main principle consists in conferring due strength for the lateral pressure. Centering is first raised, and the arch built over it. The incumbent parts over the rise or spring are called the *ponderating* parts. The chord is called the *span*, the heighth or versed sine is the *rise*. The inner circle the *intrados*, the outer or road way the *extrados*. The middles of the sides of the *crown*, or apex, are called the *lances* or flanks. The masonry above these the *spandrills*. The supports at each end are called *piers*, when there are other arches, or *abutments*, when on the fixed earth.

The *arch* is a transverse member of a building, answering the same purpose as the lintel, but vastly exceeding it in strength. The arch, unlike the lintel, may consist of any number of constituent pieces, without impairing its strength. It is, however, necessary that all the pieces should possess a uniform shape,—the shape of a portion of a wedge,—and that the joints, formed by the contact of their surfaces, should point towards a common centre. In this case, no one portion of the arch can be displaced or forced inward; and the arch cannot be broken by any force which is not sufficient to crush the materials of which it is made. In arches made of common bricks, the sides of which are parallel, any *one* of the bricks might be forced inward, were it not for the adhesion of the cement. Any *two* of the bricks, however, constitute a wedge, by the disposition of their mortar, and cannot collectively be forced inward. An arch of the proper form, when complete, is rendered stronger, instead of weaker, by the pressure of a considerable weight, provided this pressure be uniform. While building, however, it requires to be supported by a centring of the shape of its internal surface, until it is complete. The upper stone of an arch is called the *key-stone*, but is not more essential than any other. In regard to the shape of the arch, its most simple form is that of the semi-circle. It is, however, very frequently a smaller arc of a circle, and, still more frequently, a portion of an ellipse.

The simplest theory of an arch is, when it has only its own weight to bear, and may be considered as the inversion of a chain, suspended at each end. The chain hangs in such a form, that the weight of each link, or portion, is held in equilibrium by the result of two forces acting at its extremities; and these forces, or tensions, are produced, the one by the weight of the portion of the chain below the link, the other by the same weight increased by that of the link itself, both of them acting originally in a vertical direction. Now, supposing the chain inverted, so as to constitute an arch of the same form and weight, the relative situations of the forces will be the same, only they will act in contrary directions, so that they are compounded in a similar manner, and balance each other on the same conditions. The arch thus formed is denominated a *catenary* arch. In common cases, it differs but little from a circular arch of the extent of about one-third of a whole circle, and rising from the abutments with an obliquity of about 30 degrees from a perpendicular. But though the catenary arch is the best form for supporting its own weight, and also all additional weight which presses in a vertical direction, it is not the best form to resist lateral pressure, or pressure like that of fluids acting equally in all directions. Thus the arches of bridges and similar structures, when covered with loose stones and earth, are pressed sideways, as well as vertically, in the same manner as if they supported a weight of fluid. In this case, it is necessary that the arch should arise more perpendicularly from the abutment, and that its general figure should be that of the longitudinal segment of an ellipse. In small arches, in common buildings, where the disturbing force is not great, it is of little consequence what is the shape of the curve. The outlines may even be perfectly straight, as in the tier of bricks which we frequently see over a window. This is, strictly speaking, a real arch, provided the surfaces of the bricks tend towards a common centre. It is the weakest kind of arch, and a part of it is necessarily superfluous, since no greater portion can act in supporting a weight above it, than can be included between two curved or arched lines. Besides the arches already mentioned, various others are in use.

The *acute* or *lancet* arch, much used in Gothic architecture, is described usually from two centres outside the arch. It is a strong arch for supporting vertical pressure. The *rampant* arch is one in which the two ends spring from unequal heights.

The *horse-shoe*, or *Moorish* arch, is described from one or more centres placed above the base line. In this arch, the lower parts are in danger of being forced inward. The *ogee* arch is concavo-convex, and therefore fit only for ornament. In describing arches, the upper surface is called the *extrados*, and the inner the *intrados*. The *springing lines* are those where the intrados meets the abutments, or supporting walls. The *span* is the distance from one springing line to the other. The wedge-shaped stones, which form an arch, are sometimes called *voussoirs*, the uppermost being the key-stone. The part of a pier from which an arch springs is called the *impost*, and the curve formed by the upper side of the voussoirs, the *archivolt*. It is necessary that the walls, abutments, and piers, on which arches are supported, should be so firm as to resist the lateral *thrust*, as well as vertical pressure of the arch. It will at once be seen, that the lateral or sideway pressure of an arch is very considerable, when we recollect that every stone, or portion of the arch, is a wedge, a part of whose force acts to separate the abutments.

For want of attention to this circumstance, important mistakes have been committed, the strength of buildings materially impaired, and their ruin accellerated. In some cases, the want of lateral firmness in the walls is compensated by a bar of iron stretched across the span of the arch, and connecting the abutments, like the tie-beam of a roof. This is the case in the cathedral of Milan, and some other Gothic buildings.

The pressure of every arch on the abutments is equal to the weight of an upright column, containing all the materials of the arch, and all that may be laid upon it.

In an *arcade*, or continuation of arches, it is only necessary that the outer supports of the terminal arches should be strong enough to resist horizontal pressure. In the intermediate arches, the lateral force of each arch is counteracted by the opposing lateral force of the one contiguous to it. In bridges, however, where individual arches are liable to be destroyed by accident, it is desirable that each of the piers should possess sufficient horizontal strength to resist the lateral pressure of the adjoining arches.

The *vault* is the lateral continuation of an arch, serving to cover an area or passage, and bearing the same relation to the arch that the wall does to the column. A simple vault is constructed on the principles of the arch, and distributes its pressure equally along the walls or abutments. A complex or *groined* vault is made by two vaults intersecting each other, in which case the pressure is thrown upon springing points, and is greatly increased at those points. The groined vault is common in Gothic architecture.

A Roman stone bridge, over the Allier at Brioude, has 181 feet span, and is 69 feet high, but is only 18 feet wide. The modern bridge at Chester has an arch of 200 feet span, and 50 feet high. The centre arch of New London-bridge has 150 feet span.

ARCHIMEDES SCREW, is an hydraulic machine for raising water, consisting of a spiral pipe wound about a cylinder. It is very ingenious, but has ceased to be important, since the invention of so many pumps and other modern machinery for the same purpose.

ARCHITECTURE, in the general sense of the word, is the art of erecting durable, commodious, healthful, and handsome buildings of all kinds, adapted to the purposes of the builder. According to the objects to which it is applied, architecture is commonly divided into *civil architecture*, *military architecture*, and *naval architecture*. For the sake of convenience, further divisions are sometimes introduced, such as *hydraulic*, *mining*, &c. *architecture*. Architecture is often divided into private and public. The latter includes all structures commonly undertaken, or particularly superintended by government. In Germany and France, there is a building police, which oversees both public and private edifices, and takes care that security and health are provided for in both.

Whatever rude structure the climate and materials of any country have obliged its early inhabitants to adopt for their temporary shelter, the same structure, with all its prominent features, has been afterwards kept up by their refined and opulent posterity. Thus the Egyptian style of building has its origin in the *cavern* and *mound*; the Chinese architecture is modelled from the *tent*; the Grecian is derived from the wooden *cabin*, and the Gothic from the *bower* of trees.

The architecture of different countries has been characterized by peculiarities in external form, and in modes of construction. These peculiarities, among ancient nations, were so distinct, that their structures may be identified even in the state of ruins; and the origin and era of each may be conjectured with tolerable accuracy. Before we proceed to describe architectural objects, it is necessary to explain certain terms, which are used to denote their different constituent portions. The architectural *orders* will be spoken of under the head of the Grecian and Roman styles, but their component parts ought previously to be understood.

The front, or *façade*, of a building, made after the ancient models, or any portion of it, may present three parts, occupying different heights.

The *pedestal* is the lower part, usually supporting a column. The single pedestal is wanting in most antique structures, and its place supplied by a *stylobate*. The stylobate is either a platform with steps, or a continuous pedestal, supporting a row of columns.

The lower part of a finished pedestal is called the *plinth*; the middle part is the *die*, and the upper part the *cornice* of the pedestal, or *surbase*.

The *column* is the middle part, situated upon the pedestal or stylobate. It is commonly detached from the wall, but is sometimes buried in it for half its diameter, and is then said to be *engaged*. *Pilasters* are square or flat columns, attached to walls. The lower part of a column, when distinct, is called the *base*; the middle, or longest part, is the *shaft*; and the upper, or ornamented part, is the *capital*. The height of columns is measured in diameters of the column itself, taken always at the base.

The *entablature* is the horizontal, continuous portion, which rests upon the top of a row of columns. The lower part of the entablature is called the *architrave*, or *epistylium*. The middle part is the *frieze*, which, from its usually containing sculpture, was called *zophorus* by the ancients. The upper, or projecting part, is the *cornice*.

The simplest member in any building, though by no means an essential one to all, is the *column* or *pillar*. This is a perpendicular part, commonly of equal breadth and thickness, not intended for the purpose of enclosure, but simply for the support of some part of the superstructure. The principal force which a column has to resist, is that of perpendicular pressure. In its shape, the shaft of a column should not be exactly cylindrical, but, since the lower part must support the weight of the superior part, in addition to the weight which presses equally on the whole column, the thickness should gradually decrease from bottom to top. The outline of columns should be a little curved, so as to represent a portion of a very long spheroid, or paraboloid, rather than of a cone. This figure is the joint result of two calculations, independent of beauty of appearance. One of these is, that the form best adapted for stability of base is that of a cone; the other is, that the figure, which would be of equal strength throughout for supporting a superincumbent weight, would be generated by the revolution of two parabolas round the axis of the column, the vertices of the curves being at its extremities.—The swell of the shafts of columns was called the *entasis* by the ancients. It has been lately found, that the columns of the Parthenon, at Athens, which have been commonly supposed straight, deviate about an inch from a straight line, and that their greatest swell is at about one-third of their height. Columns in the antique orders are usually made to diminish one sixth or one seventh of their diameter, and sometimes even one-fourth.

A *pediment* is the triangular face, produced by the extremity of a roof. The middle, or flat portion, enclosed by the cornice of the pediment, is called the *tympanum*. Pedestals for statues, erected on the summit and extremities of a pediment, are called *acroteria*. An *attic* is an upper part of a building, terminated at top by a horizontal line, instead of a pediment.

The different *mouldings* in architecture are described from their sections, or from the profile which they present, when cut across. Of these, the *torus* is a convex moulding, the section of which is a semicircle, or nearly so. The *astragal* is like the torus, but smaller. The *ovolo* is convex, but its outline is only the quarter of a circle. The *echinus* resembles the ovolo, but its outline is spiral, not circular. The *scotia* is a deep, concave moulding. The *cavetto* is also concave, and occupying but a quarter of a circle. The *cymatium* is an undulated moulding, of which the upper part is concave, and the lower convex. The *ogee* or *talon* is an inverted cymatium. The *fillet* is a small, square, or flat moulding.

In architectural measurement, a *diameter* means the width of a column at the base. A *module* is half a diameter. A *minute* is a 60th part of a diameter. In representing edifices by drawings, architects make use of the *plan*, *elevation*, *section*, and *perspective*. The *plan* is a map, or design, of a horizontal surface, showing the ichnographic projection, or ground-work, with the relative position of walls, columns, doors, &c. The *elevation* is the orthographic projection of a front, or vertical surface; this being represented, not as it is actually seen in perspective, but as it would appear if seen from an infinite distance. The *section* shows the interior of a building, supposing the part in front of an intersecting plane to be removed. The *perspective* shows the building as it actually appears to the eye, subject to the laws of scenographic perspective.

I. The *Egyptian style* was more massive and substantial than any which has succeeded it.

II. The *Chinese* have made the tent the elementary feature; and of their style any one may form an idea, by inspecting the figures which are depicted upon common China ware. Chinese roofs are concave on the upper side, as if made of canvass, instead of wood. A Chinese portico is not unlike the awnings spread over shop-windows in summer-time. The *verandah*, sometimes copied in dwelling-houses, is a structure of this sort.

III. The *Grecian style*, from which have been derived the most splendid structures, had its origin in the wooden hut or cabin, formed of posts set in the earth, and covered with transverse poles and rafters. Its beginnings were very simple, being little more than imitations in stone of the original posts and beams. By degrees, these were modified and decorated, so as to give rise to the distinction of what are now called the *orders* of architecture.—By the architectural orders are understood certain modes of proportioning and decorating the column and its entablature. They were in use during the best days of Greece and Rome, for a period of 6 or 7 centuries. They were lost sight of in the dark ages, and again revived by the Italians, at the time of the restoration of letters.

The Greeks had three orders, called the *Doric*, *Ionic*, and *Corinthian*. These were adopted and modified by the Romans, who also added two others, called the *Tuscan* and *Composite*.

The *Doric* is the earliest and most massive order of the Greeks. It is known by its large columns with plain capitals; its *triglyphs* resembling the ends of beams, and its *mutules* corresponding to those of rafters. The column, in the examples at Athens, is about 6 diameters in height. In the older examples, as those at Pæstum, it is but 4 or 5. The shaft had no base, but stood directly on the stylobate. It had 20 flutings, which were superficial, and separated by angular edges. The perpendicular outline was nearly straight. The Doric capital was plain, being formed of a few *annulets* or rings, a large *echinus*, and a flat stone at top called the *abacus*. The architrave was plain; the frieze was intersected by oblong projections called *triglyphs*, divided into three parts by vertical furrows, and ornamented beneath by *guttæ*, or drops. The spaces between the triglyphs were called *metopes*, and commonly contained sculptures. The fine sculptures representing Centaurs and Lapithæ, brought by lord Elgin to London, were metopes of the Parthenon, or temple of Minerva, at Athens. The cornice of the Doric order consisted of a few large mouldings, having on their under-side a series of square sloping projections, resembling the ends of rafters, and called *mutules*. These were placed over both triglyphs and metopes, and were ornamented, on their under-side, with circular *guttæ*. The best specimens of the Doric order are found in the Parthenon, the Propylæa, and the temple of Theseus at Athens.

The *Ionic* is a lighter order than the Doric, its column being 8 or 9 diameters in height. It had a base often composed of a *torus*, a *scotia*, and a second *torus*, with intervening fillets. This is called the *Attic* base. Others were used in different parts of Greece. The shaft had 24 or more flutings, which were narrow, as deep as a semicircle, and separated by a fillet or square edge. The capital of this order consisted of two parallel double scrolls, called *volutes*, occupying opposite sides, and supporting an abacus, which was nearly square, but moulded at its edges. These volutes have been considered as copied from ringlets of hair, or perhaps from the horns of Jupiter Ammon. When a column made the angle of an edifice, its volutes were placed, not upon opposite, but on contiguous sides, each fronting outward. In this case, the volutes interfered with each other at the corner, and were obliged to assume a diagonal direction. The Ionic entablature consisted of an architrave and frieze, which were continuous or unbroken, and a cornice of various successive mouldings, at the lower part of which was often a row of *dentels*, or square teeth. The examples at Athens, of the Ionic order, are the temple of Erectheus, and the temple on the Ilissus, which was standing in Stuart's time, 70 years since, but is now extinct.

The *Corinthian* was the lightest and most decorated of the Grecian orders. Its base resembled that of the Ionic, but was more complicated. The shaft was often 10 diameters in height, and was fluted like the Ionic. The capital was shaped like an inverted bell, and covered on the outside with two rows of leaves of the plant acanthus, above which were eight pairs of small volutes. Its abacus was moulded and concave on its sides, and truncated at the corners, with a flower on the centre of each side. The entablature of the Corinthian order resembled that of the Ionic, but was more complicated and ornamented, and had, under the cornice, a row of large, oblong projections, bearing a leaf or scroll on their under-side, and called *modillions*. No vestiges of this order are now found in the remains of Corinth, and the most legitimate example at Athens is in the choragic monument of Lysicrates. The Corinthian order was much employed in the subsequent structures of Rome and its colonies.

Public edifices of the Greeks were their *Temples*. These being intended as places of resort for the priests, rather than for the convening of assemblies within, were, in general, obscurely lighted. Their form was commonly that of an oblong square, having a colonnade without, and a walled *cell* within. The cell was usually without windows, receiving its light only from a door at the end, and sometimes from an opening in the roof. The part of the colonnade which formed the front portico was called the *pronaos*, and that which formed the back part the *posticus*. The colonnade was subject to great variety in the number and disposition of its columns, from which Vitruvius has described 7 different species of temples. These were, 1. The temple, with *antæ*. In this, the front was composed of pilasters, called *antæ*, on the sides, and 2 columns in the middle. 2. The *prostyle*. This had a row of columns at one end only. 3. The *amphiprostyle*, having a row of columns at each end. 4. The *peripteral* temple. This was surrounded by a single row of columns, having 6 in front and in rear, and 11, counting the angular columns, on each side. 5. The *dipteral*, with a double row of columns all round the cell, the front consisting of 8. 6. The *pseudo-dipteral* differs from the dipteral, in having a single row of columns on the sides, at the same distance from the cell as if the temple had been dipteral. 7. The *hypæthral* temple had the centre of its roof open to the sky. It was colonnaded without, like the dipteral, but had 10 columns in front. It had also an internal colonnade, called *peristyle*, on both sides of the open space, and composed of 2 stories or colonnades, one above the other.—Temples, especially small ones, were sometimes made of a circular form. When these were wholly open, or without a cell, they were called *monopteral* temples. When there was a circular cell within the colonnade, they were called *peripteral*.

The *Theatre* of the Greeks, which was afterwards copied by the Romans, was built in the form of a horse-shoe, being semicircular on one side, and square on the other. The semicircular part, which contained the audience, was filled with concentric seats, ascending from the centre to the outside. In the middle, or bottom, was a semicircular floor, called the *orchestra*. The opposite, or square part, contained the actors. Within this was erected, in front of the audience, a wall, ornamented with columns and sculpture, called the *scena*. The stage, or floor, between this part and the orchestra, was called the *proscenium*. Upon this floor was often erected a moveable wooden stage, called, by the Romans, *pulpitum*. The ancient theatre was open to the sky, but a temporary awning was erected to shelter the audience from the sun and rain.—Grecian architecture is considered to have been in its greatest perfection in the age of Pericles and Phidias. The sculpture of this period is admitted to have been superior to that of any other age; and although architecture is a more arbitrary art than sculpture, yet it is natural to conclude, that the state of things which gave birth to excellence in the one, must have produced a corresponding power of conceiving sublimity and beauty in the other. Grecian architecture was, in general, distinguished by simplicity of structure, fewness of parts, absence of arches, lowness of pediments and roofs, and by decorative curves, the outline of which was a spiral line, or conic section, and not a circular arc, as afterwards adopted by the Romans.

IV. *Roman architecture* had its origin in Greek models. All the Grecian orders were introduced into Rome and variously modified. Their number was augmented by the addition of 2 new orders—the Tuscan and the Composite.—The order derived from the ancient *Etruscans* is not unlike the Doric, deprived of its triglyphs and mutules. It had a simple base, containing 1 torus. Its column was 7 diameters in height, with an astragal below the capital. Its entablature, somewhat like the Ionic, consisted of plain running surfaces. There is no vestige of this order among ancient ruins, and the modern examples of it are taken from the descriptions of Vitruvius.—The Romans modified the Doric order by increasing the heighth of its column to 8 diameters. Instead of the echinus, which formed the Grecian capital, they employed the ovolo, with an astragal and neck below it. They placed triglyphs over the centre of columns, not at the corners, and used horizontal mutules, or introduced foreign ornaments in their stead. The theatre of Marcellus has examples of the Roman Doric.—The Romans diminished the size of the volutes in the Ionic order. They also introduced a kind of Ionic capital, in which there were 4 pairs of diagonal volutes, instead of 2 pairs of parallel ones. This they usually added to parts of some other capital; but, at the present day, it is often used alone, under the name of *modern* Ionic.—The *Composite* order was made by the Romans out of the Corinthian, simply by combining its capital with that of the diagonal, or modern Ionic. Its best example is found in the arch of Titus. The favorite order, however, in Rome and its colonies, was the Corinthian, and it is this order which prevails among the ruins, not only of Rome, but of Nismes, Pola, Palmyra, and Balbec.

V. *Greco-Gothic style.* After the dismemberment of the Roman empire, the arts degenerated so far, that a custom became prevalent of erecting new buildings with the fragments of old ones, which were dilapidated and torn down for the purpose. This gave rise to an irregular style of building, which continued to be imitated, especially in Italy, during the dark ages. It consisted of Grecian and Roman details, combined under new forms, and piled up into structures wholly unlike the antique originals. Hence the names *Greco-Gothic* and *Romanesque* architecture have been given to it.

VI. *Saracenic*, or *Moorish style.* The edifices erected by the Moors and Saracens in Spain, Egypt and Turkey are distinguished, among other things, by a peculiar form of the arch. This is a curve, constituting more than half of a circle or ellipse. This construction of the arch is unphilosophical, and comparatively insecure. A similar peculiarity exists in the domes of the Oriental mosques, which are sometimes large segments of a sphere, appearing as if inflated, and, at other times, concavo-convex in their outline, as in the mosque of Achmet. The *minaret* is a tall, slender tower, peculiar to Turkish architecture. A peculiar flowery decoration, called *arabesque*, is common in the Moorish buildings of Europe and Africa.

VII. *Gothic style.* By this style is generally understood what is strictly called the *modern Gothic*, which flourished after the destruction of the Gothic kingdom by the Arabians and Moors. The style now called *Gothic* exhibits a wonderful grandeur and splendor, and, at the same time, the most accurate execution; yet it is only in modern times that its great masterpieces, as the minster of Strasburg, the cathedral of Cologne, &c. have begun to be justly appreciated. As the common place for the display of Gothic architecture has been in ecclesiastical edifices, it is necessary to understand the usual plan and construction of these buildings. A church or cathedral is commonly built in the form of a cross, having a tower, lantern, or spire erected at the place of intersection. The part of the cross situated toward the west is called the *nave*. The opposite or eastern part is called the *choir*, and within this is the *chancel*. The transverse portion, forming the arms of the cross, is called the *transept*. Any high building erected above the roof is called a *steeple;* if square-topped, it is a *tower;* if long and acute, a *spire;* and, if short and light, a *lantern*. Towers of great height in proportion to their diameter are called *turrets*. The walls of Gothic churches are supported, on the outside, by lateral projections, extending from top to bottom, at the corners, and between the windows. These are called *buttresses*, and they are rendered necessary to prevent the walls from spreading under the enormous weight of the roofs. On the tops of the buttresses, and elsewhere, are slender pyramidal structures, or spires, called *pinnacles*. These are ornamented on their sides with rows of projections, appearing like leaves or buds, which are named *crockets*. The summit, or upper edge of a wall, if straight, is called a *parapet;* if indented, a *battlement*. Gothic windows were commonly crowned with an acute arch. They were long and narrow, or, if wide, were divided into perpendicular lights by *mullions*. The lateral spaces on the upper and outer side of the arch are called *spandrells;* and the ornaments in the top, collectively taken, are the *tracery*. An *oriel*, or *bay window*, is a projecting window. A *wheel*, or *rose window*, is large and circular. A *corbel* is a bracket, or short projection from a wall, serving to sustain a statue, or the springing of an arch. Gothic *pillars* or columns are usually clustered, appearing as if a number were bound together. The single shafts, thus connected, are called *boltels*. They are confined chiefly to the inside of buildings, and never support any thing, like an entablature. Their use is to aid in sustaining the vaults under the roof, which rests upon them at springing points. Gothic vaults intersect each other, forming angles called *groins*. The parts which are thrown out of the perpendicular, to assist in forming them, are the *pendentives*. The ornamented edge of the groined vault, extending diagonally, like an arch, from one support to another, is called the *ogyre*. The Gothic term *gable* indicates the erect end of a roof, and answers to the Grecian *pediment*, but is more acute. In general, the Grecian style, from its right angles and straight entablatures, is more convenient, and fits better with the distribution of our common edifices than the pointed and irregular Gothic. The expense, also, is generally less, especially if any thing like thorough and genuine Gothic is attempted.

The Tuscan is the Doric, a little shorter in the column, and without its triglyphs. The composite is a blending of the Ionic and Corinthian, but without improving the splendour of the latter.

There can be no doubt whatever but the idea of a base and a capital originated in Egypt, to relieve the massive assemblages, and they were merely lightened and varied by the Greeks.

Every order is distinguished by the construction of its principal parts—the column and the entablature. The Doric has no base; but, in the others, the column consists of the bases, the shaft, and the capital. The moulding of the base differs in each. The shaft is the plain or fluted frustrine of a cone in fixed proportions. The capital is the variously-ornamented part, regular in each order. The entablature or horizontal bearing is divided into 3 parts, the architrave, the frieze, and the cornice. The architrave has 1 or more faces, and is capped with a simple or compound moulding. The frieze is plain or ornamented with sculpture or inscriptions. The cornice is the collection of mouldings above the whole, and crowns the entablature.—*See* ARCH, BUILDING, DOME, ROOF, CARPENTER, &c. &c.

ARCTIC, an epithet given to the

north pole; or the pole raised above our horizon. It is called the *arctic pole*, on account of the constellation of the Little Bear, in Greek the name of the last star, in the tail whereof is the north pole. This and its opposite, the *antarctic*, are called *the two polar circles*, in lat. 66° 32′

ARCUATION, is a method of raising, by layers, any tree which cannot be raised by seed. It consists in bending into the ground the branches which spring from the offsets or stools. The plant depends chiefly upon external influences, and therefore a part, which has become a branch by the influence of air, may be turned into a root by the influence of the earth. After a time they become roots, and put forth foliage.

ARE, a superficial square measure in France, substituted for the former square rod. It consists of 1076·44 English square feet. The 10th part of an are is called a *deciare*, and the 100th a *centiare*. *Dec-are* is a surface of ten ares.

AREAS, or superfices, are the products of length by breadth; irregular figures being divided into regular ones, or reduced to regular ones, by the analogy of small with great.

Thus the area of a regular square rectangular figure, or rhombus, is the length by the breadth.

Of a triangle, is half the product of the base by the perpendicular height.

Of a trapezoid, is the half of the two unequal parallel sides by the heighth.

Of any irregular figure of many sides, is the sum of the areas of all the triangles which compose it.

Of any regular polygon, is half the product of all the sides, by the distance from the centre to the middle of either sides.

Of the area of any circle, is the fourth of the diameter by the circumference; or it is the square of the diameter by 0·7854; or it is the square of the circumference by 0·07958.—*See* ACRE.

The area of a circular plane ring is the difference of the two circles.

The area of the sector of a circle is one-fourth of the circle's diameter into the arc.

The area of a segment of a circle, when less than a semi-circle, is the area of the sector of equal degrees, from which is to be deducted the area of the triangle, lying between the chord of the segment and the centre of the circle. If the segment is greater, find the less, and deduct it from the area of the entire circle.

The area of an ellipsis is the product of 0·7854, and the longest and shortest diameters.

The area or surface of a sphere is the product of the diameter by the circumference, or it is the square of the diameter into 3·14159.—*See* CIRCLE and CUBE.

There are 4840 square yards in an acre, hence about 70 yards each way is 4900 yards, or nearly an acre, and exactly 69·57; and any 2 dimensions in yards which multiplied together produce 4840 are an acre, or obvious part of 4840.

ARGAND LAMP, a lamp with a circular wick, so that the air passes through its centre, and produces a superior flame. It is also enclosed in a glass, within which is another current of air; so that the flame has a double current of air.

The glass of argand and other lamps may be secured from flying by an incision or stroke with a diamond from top to bottom. This prevents the decripidation. Etchings of figures diffused from top to bottom answer the same purpose.

A cone with an aperture at the top, placed over an *argand burner*, gives a simple flame without smoke, and with great increase of intensity.

ARGENTUM.—*See* SILVER.

ARGOL, is the name of tartar, and a crust in bottles, tuns and casks, in which wine has been kept. It is an acid in union with potash, hard and brittle, and on purification is called cream of tartar. Its colour in its impure state depends on that of the wine. It is much used in medicine and as a mordant by dyers; it also is the basis of a numerous tribe of salts called tartrates.

AREOMETER, The. The areometer of Homberg is still the best instrument for the examination of liquids. It is a bottle of very thin glass, with two necks, which are drawn out to such fineness, that a single drop of water may occupy the length of about half an inch in them. One of these necks is longer than the other, and dilated at the mouth like a small funnel; and each of them has a fine mark, made nearly on a level with the top of the shortest. The weight of water that this areometer holds being ascertained, and noted down, then, when it is filled with any other liquid, up to the marks, and the weight of the liquid ascertained, by dividing the weight of the liquid by the weight of the water, the quotient is the specific gravity of the liquid. The exact quantity of water, or liquid, to fill it to the two marks, is adjusted by adding, or taking out, a small quantity by the point of a fine hog's bristle, or, in some very corrosive liquids, by a fine thread of glass. The use of the second short pipe is to let the air escape, as the liquid is poured into the areometer by the long pipe.

For conducting this experiment with greater facility, a specific gravity bottle is sold under the name of a "*thousand-grain bottle*," together with a weight which is an exact counterpoise for it when filled with distilled water at 60° Fahr. It is a glass bottle with a slender neck, and is furnished with a ground conical stopper, in the side of which there is a notch, or indentation, by which the operator is enabled to put in the stopper, after the vessel has been completely filled, the redundant fluid escaping through this groove. Unless such a contrivance were adopted, it would be difficult to fill a bottle with liquid without inclosing some bubbles of air. This instrument does not require the aid of any computation, but is simply filled with the fluid to be examined, and placed in one scale of the balance, while its counterpoise is placed in the other. If the contained fluid be lighter than water, it will appear deficient in weight, and as many grains must be added to the scale that contains it, as may be sufficient to restore the balance. This shews, at once, that the specific gravity of the fluid in question is less than the standard, and, consequently, that it must be expressed by a fractional number; but should the fluid be heavier than water, the bottle will preponderate, and weights must be put in the opposite scale, when their amount must be added to that of the standard. Thus, if the bottle were filled with sulphuric ether, it would require 261 grains to be placed in the same scale, to restore the balance, and, consequently, its specific gravity would be 0·739.

Another very similar contrivance is that called *the cubic-inch bottle*, a bottle which exactly holds *a cubic inch*, when the stopper is in its proper place, and is very convenient, and frequently used for readily ascertaining the absolute gravity in a cubic inch of different liquids.

AREOMETRICAL BEADS. — It was long customary to use a new-laid egg, or a piece of amber, to ascertain when brines were boiled down sufficiently for crystallization, but it has been proposed to measure the specific gravities of fluids by a series of small glass beads, or hollow balls, differing from each other in specific gravity, since all those heavier than the fluid sink to the bottom, while those lighter float. But areometrical beads have been brought to very high perfection, and are now used by distillers and chemists in general. They are fitted up in boxes, containing different quantities, and they are numbered to every two units in the third place of specific gravity; for example, 920, 922, 924, &c. We have only to put a parcel of them into the fluid till we find the one that stands without either rising or sinking, and the number marked upon the bead will indicate the specific gravity of the fluid. The beads are accompanied by a sliding rule, and a thermometer for making corrections for temperature, and finding the strength of the spirits, in the language of spirit-dealers. If two beads (one rather lighter than the proper specific gravity of the liquid when fit for use, and the other rather heavier) sink, the liquor is not brought to the proper point; but, if both float, it is too strong; the proper strength being when one floats and the other sinks.

ARITHMETIC, or the science and practice of numbers, is the fundamental basis of all pursuits of knowledge. As commonly taught, it creates difficulties which it does not remove. Its numeration does not accord with its practices. The numeration is by tens and tenths, but the fractions of society are not by tenths, and hence the arithmetic of schools and that of real life are different. But since society will, in spite of arithmetical notation, continue to divide shillings into 12 pence, pounds into 16 ounces, and miles into eight furlongs, it seems proper that the schoolmaster should yield, and that, as his primary task, he should adapt all these discordances to the principles of notation which he teaches. If he teach a science of tens, 10*s*. 6*d*. or 115 lbs. 2 oz. or 210 miles 5 furlongs, are impracticable quantities to every one of his scholars. His first step (instead of his last) ought, therefore, to be to teach his pupil to express all kinds of quantities and their fractions in his decimal notation. Thus, 6*d*. is $\frac{6}{12}$ths of a shilling, 2 oz. is $\frac{2}{16}$ths of a lb. and 5 furlongs $\frac{5}{8}$ths of a mile. The rule to bring these into 10ths, so as to range with his shillings, lbs. and miles, is very simple, and merely consists in multiplying the numerators 6, 2, and 5, by 10, 100, 1000, &c. as necessary, till no remainder arises, and dividing by the denominators 12, 16, and 8. The quotient is a decimal fraction, which ranges in 10ths with the 10, 115, and 210, and thus has an arithmetical value in accordance with the tenths of arithmetical notation. Thus, multiplying 6 by 10, we get 60 10ths, and this, divided by 12, is 5 10ths. Then, in arithmetical notation, 18*s*. 6*d*. is 18·5, that is, eighteen shillings five tenths.

So 2, multiplied 10 or 1000, is 2000 thousanths, and this, divided by 16, is 125 thousandths; that 115 lbs. 2 oz. is, in scholastic arithmetic, 115·125 lbs.

Again, 5 by 1000 is 5000 thousandths; which, by 8, is 625 thousandths; and 210 miles 5 furlongs is properly 210·625 miles.

The advantage is this, that we can deal with 18·5, 115·125, and with 210·625, as the common notation by tenths, for the value is by tenths, descending from right to left, and ascending from left to right; and thus we can add, subtract, multiply, divide, &c. each of them, as whole numbers, without being perplexed with the social artificial divisions of pence, ounces, and furlongs.

But these cases are taken in their simplest forms for illustration; and it often happens, that the quantities are very complicated, though in decimal expression perfectly simple. The rule, in adding and subtracting, is to place equal tenths in line; in multiplying to cut off as many figures for the fraction as there are fractional figures in the factors; and in dividing to cut off their difference.

Values of decimals, in any of the odd fractions of society, are found by a converse operation, that is, multiplying by the denominator, and dividing by 10, 100, or 1000, as it may be. Thus 5 by 12*d.* is 60 tenths, and this, by 10, is 6*d.* So ·125 by 16 oz. is 2000 thousandths, and this by 1000 is 2 oz. Again, ·625 by 8 furlongs is 5000 thousanths, and this by 1000 is 5 furlongs.

For want of this simple explanation, and from inattention to the harmonizing of scholastic decimal notation with the fractional notation of life, young persons, in passing from school to business, find the arithmetic which they have learnt so useless to them; and then, if they turn to books of science, where every thing is expressed in the uniform notation of decimal wholes and decimal parts, they are deterred from the pursuit by ignorance of the notation. At the same time, in learning numeration, it would have been as easy to learn to read tenths, hundredths, &c. to the right of the dot, as tens, hundreds, &c. to the left of the dot.

It is simply contended, that as the scholastic arithmetic is by a notation of tens, and as the arithmetic of books is the very same, that it is highly improper to teach any other arithmetic, and that the first step ought to be to teach learners how to convert the odd and capricious fractions of society into the practicable and uniform notation of arithmetic.

ARMILLARY SPHERE, an ancient, and now obsolete, display of the artificial circles with which the earth is imagined to be enveloped. The same circles are found on both globes, and their nature and uses are rendered evident by consulting books on the globes, of which that by Miss Phillips is, beyond question, the most practical for learners and preceptors.

ARNATTO, or ANNOTTA, a red dyeing drug, produced from the pulp of the seed-vessels of a shrub (*bixa orellana*,) which grows spontaneously in the East and West Indies. It is seven or eight feet high. The seed-vessels are like the chesnut, and each contains from 30 to 40 seeds, in pulp of red colour and unpleasant smell, like red-lead, mixed with oil. The pulp is boiled, and the seeds which are mixed with it, until extricated. The pulp is allowed to subside, and the sediment is distributed into shallow vessels, and gradually dried. It is chiefly prepared by the Spaniards, for the purpose of mixing with chocolate, to which it gives colour and improved flavour.

The principal consumption is by painters and dyers; and Scott's nankeen dye is arnatto in alkaline lye. Dutch farmers use it to colour butter; and Gloucester, and other kinds of cheese, are coloured with it. The bark is manufactured into ropes, and pieces of the wood are employed to procure fire by friction.

ARNICA is a common continental plant; the leaves and flowers of which are stimulating and the root tonic. German physicians consider it little inferior to bark, and it has been found very useful in paralysis, &c. The infusion, in fluid ounces, or powder, in 5 or 10 grs. is administered two or three times in 24 hours.

AROMATICS, or Carminatives, are cardamoms, aniseed, peppermint, bergamot, &c.

ARQUEBUSADE WATER. Take 2 galls. of alcohol, and for a fortnight steep therein 4 oz. of these components, sage, wormwood, fennel, hyssop, rue, marjoram, lemon-thyme, peppermint, savory, balm, thyme, rosemary, wood-sage, fresh angelica flowers, basil, and lavender. Distil to one and a half gallon.

ARRACACIA, a plant, said to produce a new species of potato, which Bancroft determined to belong to a new *genus*, to which he gives the native name of the plant, with a more euphonious termination, Arracacia, and the *species* he designated *xanthorhiza*.

It would seem that a vegetable, which has, for many ages, been the constant and favourite food of a considerable portion of the population of South America, *in preference to the potato*, which is there indigenous, ought not to receive a fair trial in the way of cultivation in Jamaica and every where. The fruit is still a desideratum; neither in Trinidad, nor in Jamaica, nor in Britain, have perfect seeds been formed, the fruit having invariably fallen away before the seeds were ripe. The plants increased considerably by the roots; and, by removing the offsets from the parent roots, and keeping them through the winter, as the roots of dahlias are kept, they vegetate readily in the spring, and succeed best in a warm situation, even in the open air.

Bancroft gives the following as the method of cultivation at Bogotà:—After separating the upper tubers, or knobs, from the root, detach from these the offsets, singly, each with its portion of the substance of the tuber, which is then to be pared smoothly all round at the bottom, the outer leaves being stripped or cut off, so as to leave a sprout from half to two or three inches at the most. Germs or eyes at the base of the offsets must be carefully cut out. The shoots, thus prepared, are to be planted in the loose mould, in a slanting direction, fifteen or eighteen inches from each other. When the plants have attained the height of ten or twelve inches, or whenever they show a disposition to blossom, the budding tips should be taken off, as flowering hinders the root from attaining its greatest size; care being taken not to remove more than the budding extremities, lest the growth of the root should suffer, and, with the same view, any luxuriance in the shoots should be prevented. After weeding the ground, fresh mould should be laid round the foot of each plant, to aid in the enlargement of the root. In favourable situations, it attains its full size in six months. It does not seem to require a rich soil or much moisture; since, on a loose poor soil, in St. Andrew's Mountains, where very little rain falls, it arrives at maturity in eight months.

In Bogotà and Popayan, a succession is obtained through the whole year, by planting shoots every month. The root, rasped and macerated in water, deposits fine flour, which is in general use as light nourishment for delicate appetites.

This information relative to a vegetable of great promise, as an article of common diet, is taken from the 56th number of *Curtis's Botanical Magazine*, where a drawing and full description of the plant is given.

ARRACK, the East Indian name for all ardent spirits. It is chiefly distilled at Goa, from the fermented juice of the cocoa-nut, called toddy. At Batavia it is a distillation from a fermentation of rice and sugar; but they use copper stills, while at Goa they make a very superior article from toddy in stills of earthenware, and so strong that the alcohol is but a sixth or eighth.

Arrack, Mock, is made by adding two scruples of benzoic acid to a quart of rum.

ARROW-ROOT, starch manufactured from the roots of a plant, the *maranta arundinacea*, cultivated in gardens in the East and West Indies. It is about two feet in height. The roots are dug when a year old, well washed, and beat in deep wooden mortars till reduced to a milky pulp. This is washed again in clear water, and the fibrous parts carefully separated. It is next passed through a sieve, and suffered to stand till the starch has settled. The water is then drawn off, and the white residue is again washed; after which the pulp, when dried in the sun, is found to be pure starch, which, reduced to powder, is arrow-root. No vegetable, except salep, or orchis-root, yields so large a proportion of mucilage. As an article of diet it is invaluable, especially in bowel complaints. The purest is the Jamaica or Bermuda. Too much that is sold is the fecula of potatoes, 100 lbs. of which yield 10 lbs. of what is called arrow-root.

In no article of diet have greater impositions been practised than in arrow-root. The farina of mealy potatoes has been very generally sold for it, or used to adulterate it. The colour of the potato-starch is more white than that of the best arrow-root of the West Indies, and with boiling water it forms a good jelly, but in the course of 12 hours it becomes nearly as thin as milk, and acescent. Hence the potato flour is an unhealthy article of diet for infants and invalids. The arrow-root of Antigua appears to be superior to that of Jamaica. The jelly it forms with boiling water continues firm for three or four days, and does not become sour for several days. Of this arrow-root there are two or three qualities, which depend on the number of ablutions to which it has been subjected, for the purpose of bleaching it. When well washed with good water, it is nearly as white as the potato starch, but by much washing, its glutinous quality is diminished, and it is consequently less nutritious. The second quality, which is equally pure, although not so white, affords the strongest jelly, and therefore, as a food for children, should be preferred.

ARSENIC is a very common metal, being found in combination with nearly all of the metals in their native ores. It is of a bluish-white colour, readily becoming tarnished on exposure to air, first changing to yellow, and finally to black. In hardness, it equals copper, is extremely brittle, and is the most volatile of all metals, beginning to sublime before it melts. Its specific gravity is 5·736.

It burns with a blue flame and a white smoke, emitting a strong smell of garlic.

It commonly bears the name of *black arsenic*, and is prepared from the white arsenic of commerce, by heating this substance with carbonaceous matter, and allowing the volatile arsenic to condense in an adjoining vessel.

Arsenical pyrites, a very abundant natural substance, is also advantageously used in the preparation of arsenic, in which case iron filings and lime are added, to engage the sulphur, and prevent its sublimation along with the arsenic. Native arsenic has been found in the veins of primitive rocks in several countries, but in small quantities, and generally alloyed by the presence of iron, silver, or gold. This metal is used in metallic combinations, when a white colour is desired.

With oxygen, arsenic forms two compounds, both of which, from their property of combining with alkaline and earthy bases, are called *acids*. The arsenious acid, the most important of the two, is the *white arsenic* of the shops. It is usually seen in white, glassy, translucent masses, to which form it is reduced by fusion from a powdery state.

It is one of the most virulent poisons known, not only when taken into the stomach, but when applied to a wound, or even when its vapour is inspired. It is found native in small quantities, but is obtained for use from the roasting of several ores, particularly from that of cobalt and arsenical pyrites. The arsenious acid is condensed in long, horizontal chimneys, leading from the furnaces where these operations are conducted, and usually requires a second sublimation, with the addition of a little potash, to deprive it of any sulphur it may contain. Its manufacture has been chiefly confined to Bohemia and Hungary. Persons brought up from their youth in the works live not longer than 30 or 35 years.

Besides its use in medicine, it is much employed as a cheap and powerful flux for glass; but, when too much is added, it is apt to render the glass opaque, and unsafe for domestic use. Arsenite of potash, mingled with sulphate of copper, affords an apple-green precipitate, called *Scheele's Green*, which, when dried and levigated, forms a beautiful pigment.

With sulphur, arsenic forms, likewise, two definite compounds—the *realgar* and *orpiment*. The former of these contains the smallest proportion of sulphur, and is red; the latter is yellow. They are both found native in many countries, but their supply in commerce depends upon their artificial manufacture. This is done by distilling a mixture of arsenical pyrites and iron pyrites, or of white arsenic and rough brimstone. Realgar or orpiment is obtained as the proportion of sulphur employed is greater or less. These compounds afford valuable pigments to the painter.

Arsenic Acid, is made by several distillations of arsenious acid 1, with nitric acid 3. It is 1 arsenic and 3 oxygen. Arsenious acid is 1 arsenic, 2 oxygen, and is procured by burning the metal.

Arsenic, Black, is the commercial name of the metal arsenic, and is manufactured by distilling powdery white arsenic with charcoal dust, and some iron filings and lime, so that if any sulphur is contained in the white arsenic it may not rise. Arsenical pyrites, ground fine, is also used, and preferable. The apparatus is the same as for red arsenic, only a sheet of iron, rolled up like a cylinder, is used as an adapter. When the apparatus is cooled, this iron adapter is unluted, and being unrolled, the black arsenic is found sublimed upon it in brilliant crystals, which soon grow black.

In the neck of the receivers there is found a mass composed of black arsenic and white arsenic, which is sometimes sold by the name of *fly-stone*.

Arsenic, Red, or *Realgar*, is manufactured by distilling a mixture of arsenical pyrites with iron pyrites, or of powdery white arsenic with rough brimstone. The distillation is performed in earthen retorts, coated with a mixture of clay, iron filings, blood, hair, and alum. These retorts are filled about two-thirds, ranged in a galley furnace, and an earthen receiver is luted to each. The receivers are pierced with a few small holes, to prevent an explosion. The firing lasts eight hours, and when the apparatus is cooled, the red arsenic mixed with some yellow arsenic is taken out of the receivers; the yellow part is added to the mixture used in the next operation.

The red arsenic, thus obtained, is melted over again, under a chimney that has a quick draught, to carry off the vapours. It is melted in a cast-iron pot, set in brickwork; when melted, it is scummed, and ladled quickly into sheet iron-moulds, which are immediately covered, and left to cool. The mixture of the charge must be properly proportioned, so that there may be from $3\frac{1}{4}$ parts to 5 parts of white arsenic to 1 of sulphur. The residue left in the retorts is stored up, to be used in making copperas.

Arsenic, White, is obtained in a powdery form, as a secondary product in the chambers attached to the furnaces for smelting lead and tin ores, and in several other processes. Arsenical pyrites are also roasted expressly for the purpose in reverberatory furnaces, with chambers attached. As white arsenic is, in this form, very dangerous in carriage, on account of its poisonous quality, it is reduced to a glassy innoxious form, by sublimation in iron matrasses, formed of several pieces luted together. Two of these matrasses are usually heated over one fire, in a furnace about 12 feet long, 6 wide, and 4 high. The two cast-iron pots which are set in this furnace, and serve as the bottom of the matrass, are two feet wide, and as many deep, hanging loose in the furnace by a flange round their mouth. Each of these iron pots are charged with 3½ cwt. of powdery white arsenic, and then covered with a head of cast or hammered iron. These heads are cylindrical, four feet high, as wide as the pots, and contracted at top into a cone, a foot high, to which is adjusted a long pipe of sheet-iron, a few inches wide, and ending in a chamber built over the furnace, and having a chimney at one end.

The joints between the pot and the head being luted with clay, mixed with blood and hair, the fire is lighted and kept up for 12 hours, after which the apparatus is left to cool till next day, when the head being taken off, the glassy white arsenic sublimed in it is knocked off and sorted; the whitest parts are packed in barrels for sale, and the impure parts, as well as that left in the pot, reserved for another sublimation. Each pot produces about 3 cwt. of glassy white arsenic, and the heating of the two pots consumes about 90 lbs. of pitcoal. In some workshops, the heads put over the pots are open at top, the pots are not charged but when they are red-hot, a few pounds of powdery white arsenic are flung in at the top of the head, the opening of which is then closed with a tile; and this is repeated at short intervals.

If the powdery white arsenic contains any sulphur, a little potash is mixed with it, to prevent the sulphur rising.

Arsenic, Yellow, or *Orpiment*, is manufactured by mixing arsenical pyrites that have been exposed a long time to the air, with a tenth their weight of iron pyrites, and distilling the mixture in earthy retorts.

Arsenic is separated from foreign substances by mixing it with *black flux*, and putting it into a crucible with another luted over it, with clay and sand. On applying a red heat to the under vessel, the metallic arsenic covers the inside of the upper vessel.

ARSENIOUS ACID, an important pharmaceutical article, and a very active and powerful poison. Sp. gr. 3·7; 25 oxygen, 75 metal; or, as arsenic acid, 33⅓ to 66⅔. The vapour of the metal has a garlic smell, but not the acid, unless it be decomposed. The fumes of the arsenic mineralizer in the copper-smelting and tin-burning, in Cornwall, and near Swansea, produce melancholy effects on vegetation and animals. Trees and shrubs lose their leaves, and Dr. Paris tells us, that horses and cows lose their hoofs and are subject to various painful diseases. The workmen protect themselves with *sweet-oil*, of which they use great abundance, but it causes gangrene of the scrotum, and is a very pernicious employment. Nevertheless, arsenious acid is used as medicine, in pills containing the tenth of a grain, with sugar and crumb of bread. A cup made of realgar, sulphuret of arsenic, confers a cathartic power on lemon juice, allowed to stand in it.

Arsenious Acid, or the white oxide, in small doses, is useful in ague and recurring head-aches; externally in cancer, in rheumatism, dropsy, syphilis, &c. and much used, in India, in those and other diseases which require stimulants. The tenth of a grain is a dose, in combination with sulphur. It is applied to cancerous sores, either as powder, lotion, or ointment.

ART AND MYSTERY, the term used in articles of apprenticeship, implying that the master is to teach his art and mystery to the youth in return for premium and service. The terms apply to all cases, for apprenticeships are commonly for the same term, though arts and mysteries vary so much in intricacy. In many arts the apprentice has more to learn than even seven years can teach, as in the arts of a carpenter, mill-wright, cabinet-maker, printer, publisher, lawyer, chemist, druggist, farmer, house-surveyor, &c. &c. while in many handicraft trades, and wholesale and retail employments, 2 or 3 years are quite sufficient, and in most manufactories which consist of an unvarying circle of one operation or one mixture, 2 or 3 months suffice to teach all that is to be learnt. This difference in binding for seven years ought to govern the terms of apprenticeship, since in arts and mysteries of difficult attainment the apprentice makes small returns to his master; but, in simple practices, where perfection is attained in a few weeks, the advantage of service is entirely on the side of the master. In most manufactories performed by machinery, simple inspection of duty, in subservience to the machine, teaches all that is to be learnt, yet we find hard-hearted and insolent overseers of the poor, or parish committees, &c. binding children for seven years, not to learn, but to serve, for the sole benefit of the master, who at the same time never employs those whom he has taught, but carries on his trade by a constant succession of apprentices, abandoning them to the world as soon as they are out of their time.

ARTEMISIA, is the name of several species of wormwood, a common perennial plant, each of which have useful medical qualities. Of 100 parts, 56 are bitter or resinous. It is employed in dropsy, gout, epilepsy, and hypochondriacal affections. Boiling exhales its narcotic principle. 1 or 2 scruples is a dose of the powder, and a fluid ounce of the infusion, made by pouring a pint of boiling water on 6 drachms. The Chinese species yields downy fibres, which, rolled into cones, is the best moxa, other kinds being made from the pith of the sun-flower. These, as is well known, are then used as cauteries, to produce counter irritation in obstinate local inflammations. But Dr. Thomson, in the London Dispensatory, recommends iron at a white heat in preference, covering the surrounding parts.

ARTERIAL CIRCULATION, is the distribution of the blood from the heart, when it is received from the lungs, and has there undergone the oxydating and heating process, by converting pure air into carbonic acid gas. The blood in the arteries is about 10 or 12 lbs. or pints, and the arteries fine off to insensible threads, depositing the blood in apposition to the skin, through which it is alkanized by the atmosphere, and then taken up or absorbed by the veins, and carried back for oxidation to the lungs. The idea that the arteries and veins are continuous, is not supported by fact, for the continuity never could be traced even with the best microscopes. The blood is distributed through the arteries, and reassembled in an altered state by the veins, a fact unaccordant with the hypothesis of continuous circulation, and also with the known effects of topical bleeding. The blood in the body of a man is about 24 or 30 lbs. and the greater part is in the arteries and veins, that in the lungs being subjected to many respirations before it is transmitted to the heart.

The alternate contractions and dilatations of the heart force the blood into the principal arteries, with a direct velocity of 149 feet per minute, after which it moves slower. The quantity in a full-grown man is from 24 to 30 lbs. or from 3 to 4 gallons. The blood returns by the veins to the right auricle, the contraction of which drives it to the lungs, where it is oxydated, reddened, and quickened by the oxygen of the inspired air. It then returns to the left ventricle, and is expelled by another contraction into the arteries and distributed through the body. It is then recollected by the veins, and carried back to the heart. In blood-letting the superficial veins are opened, and not the arteries, which are fewer in number and deeper seated. The ascending vein receives the chyle from the lymphatics and lacteals.

ARTERIES, are the blood-vessels which convey the blood *from* the heart through the body. The ventricle or outlet, or great trunk at the heart, is called the *aorta*, and the force of circulation is produced by the contraction of the heart. The branches subdivide till invisible, and seem to distribute the blood into every part. No connection between the termination of the arteries and the commencement of the veins was ever seen or traced, and the theory of such connection, though so dogmatically asserted, is a mere hypothesis. On the contrary, our improved knowledge of the compound character of atmospheric air, ought now to lead us rather to suppose that the arteries merely distribute the oxygenated and heated fluid, and that the veins collect in connection with the air at the skin, the animal circulation to and fro resembling that of a tree. The lungs *oxygenate*, and the skin *nitrogenates*, sustaining an action and re-action, through the *intermediate* system, akin to the *positive* and *negative* action of electricity or galvanism. It is this which confers distinct colours on the arterial and venous fluids.

ARTESIAN, is the name given to wells or springs, formed by boring in the ground. This is a new and very important art, and in many respects a great discovery of our own age. Elkington found that by boring for certain depths he could drain off standing water, so as to run away in the porous strata of lower levels, and this was an invaluable agricultural improvement. Smith then discovered the regular inclination or oblique dip of the strata, by boring through which, we might either let off or raise water, as the strata were porous or impervious. It thus appeared that the sheets of oblique strata determines the courses of water beneath the surface, and that as water will rise again to its first level, so by boring in any place where there are higher impervious strata, the water rises in the bore, not merely to the surface, but often in a very considerable fountain. Hence, districts which in all past time have been without water, are abundantly supplied, and in this way the most arid districts of the earth may be supplied with abundance of well-filtered and pure water. By adding lengths to steel and other augurs, and by a shaft and horse-power, the hardest substances and depths of 6 or 800 feet have been penetrated, nearly all with astonishing success.

Vallance suggests that, in many situations, wind may be employed for *boring the earth*, and in giving an account of a *boring machine*, of which wind is the moving power, he premises that in boring through hard stones, the auger must have a slow, rotary, and a quick striking motion, at the same time; that is, it should give ten, twelve, or fourteen strokes for each revolution, more or less, in proportion to the hardness of the stone; while in boring through softer substances, or cleaning the hole, the rotary motion only is to be used. His machine is worked by a horizontal wheel about 3 ft. 6 in. diameter, with ten, twelve, or fourteen handspokes fixed in it; its axle or nave is 1 ft. in length, and 1 ft. diameter, and bound with a strong hoop of iron at each end; a cast-iron bush passes through the axle of the wheel, and serves both for the wheel to turn round on, and for the boring rod to work up and down in. The boring rod is of an oblong square shape, 2 in. thick and 3 in. broad, where it works in the bush, and 5 or 6 ft. long. By turning round the wheel, the handspokes catch a crank which gives a striking motion to the rod, but when boring through soft substances, or cleaning the hole, these spokes may be taken out. A rope or chain is let down the rod as it works its way, 4 or 5 ft., when another length of rod is screwed to it, and so on, until the hole is deep enough. The rope or chain is fixed to the crank, and passes over a pulley, and is attached to the rod by a swivel, to prevent the chain from twisting. The arm of the crank next the wheel is perpendicular, and the arm that the chain is fixed to horizontal.

The irruption of the water, on first piercing these subterranean reservoirs, is often very violent, and is no small proof of the copiousness of many of these wells. Mr. Brook lately sunk a bore in his garden, previously without water, 360 ft. deep, and 4·5 in. in diameter, from which the water was discharged so copiously, that it not only overflowed the whole yard round the house, but also submerged the adjoining cellars. Two men now tried to close the bore with a wooden peg, but they were driven back by the violence of the water, and they were incapable of restraining the water by an iron stopper. At last they planted several tubes over the bore, and thus succeeded in controuling the water. At Mr. Lord's, Tooting, where a bore had been closed, the water worked with such violence, that it burst forth in a space 15 yards in circumference, and the adjacent walls would have been brought down, if free vent had not been given. The stream of a well, belonging to a neighbour of Mr. Lord, drove a water-wheel of 5 ft. in diameter, and this again set a pump in motion which carried the water to the top of a three-storied house. Two kinds of water are sometimes found in a single boring, such as *hard* and *soft* water.—*Timbs' Arcana of Science.*

An Artesian Well has been bored in the Duke of Northumberland's grounds at Sion, to the depth of 535 ft. The first 20 ft. bored through consisted of loose gravel and sand; to this succeeded strong blue clay, to the depth of 410 ft.; next 10 ft. of green sand; then between 30 and 40 ft. of loose chalk; and, finally, very firm and hard chalk, to the depth of 535 ft., which is said to extend to an unknown depth. A strong spring was found in the green sand, but it was not powerful enough to rise higher than 3 ft. from the surface. The next spring was found in the solid chalk; and the two springs, united, now rise to the height of 5 ft. above the surface, and the water flows over at 5 gallons per minute, of a constant temperature of 55°.

ARTICHOKE. The artichoke (*cynara scolymus*) is a well-known plant, cultivated in England as early as 1580. Parts that are eaten are the receptacle of the flower, which is called the *bottom*, and a fleshy substance on the scales of the calyx.

In England, artichokes are generally boiled plain, and eaten with melted butter and pepper. The bottoms are also stewed, boiled in milk, or added to ragouts, and highly-seasoned dishes. On the continent, they are frequently eaten raw with salt and pepper, and the flowers are used to coagulate milk, for cheese, in which they succeed.

The leaves and stalks contain a bitter, which, mixed with white wine, has been employed in the cure of dropsy.

The juice, prepared with bismuth, imparts a permanent gold color to wool.

*Jerusalem Artichoke*, a some-what potato-shaped root, is produced by a sun-flower. So extremely productive are these roots, that between 50 and 60 tons, or 110,000 lbs. are said to have been obtained from a single acre, or 300 lbs. weight for every day in the year, *i. e.* 6 or 7 times more than the potato! They succeed in almost every soil; and, when once planted, will continue to flourish in the same place, without requiring much manure, or much attention. Jerusalem artichokes are also a nutritive food for hogs, and if washed, cut, and ground in a mill similar to an apple-mill, they may be given to horses, cows, &c.

ARTIMOMANTICO. This metallic compound, resembling gold in colour and weight, was lately invented at Leghorn. It is of the same weight as gold of 18 carats, and can be made like that of 24. At a manufactory of it, established at Bologna, metal buttons are made of it at 2*s*. 6*d*. per doz.; and when new, they resemble the most highly-gilt buttons. The inventor sells the metal to the manufacturers at Bologna, at 12*s*. per lb. of 12 oz. which makes 9 dozen of coat-buttons. It is soft and bends, but founds its superiority to other gold-coloured metals on not tarnishing.

ASAFŒTIDA, is a gum, procured from the root of a plant (*ferula assafœtida*,) which grows in the mountains of Persia. The leaves are nearly 2 ft. long. It constitutes seasoning for food in many parts of the east, and the Banians use it in almost all their dishes.

In Arabia and Persia, it is much esteemed as a remedy for internal diseases, and as an external application to wounds. In Europe it has been applied in the cure of hooping-cough and worms; and in flatulent colics it affords relief. In the season when it is collected, the whole county smells of it. The upper part of the roots, as thick as a man's leg, rises above the surface of the ground, and the harvest commences when the leaves begin to decay. A single ship is exclusively devoted to transporting it to the ports in the East, and when smaller parcels are carried, it is usual to tie them to the top of the mast.

ASBESTUS, a mineral substance presenting much diversity in its structure and color. It occurs in long, parallel, extremely-slender, and flexible fibres, (*amianthus* ;) in finely-interwoven and closely-matted filaments, forming flat pieces (mountain leather;) in fibres interlaced so as to form numerous cells resembling cork (mountain cork;) in hard, brittle, slightly-curved fibres (mountain wood ;) and in compactly-fibrous masses, harder and heavier than the other varieties (common asbestus.) Its most common colours are gray, yellow, green and blue, intermingled with white. It is found in all countries more or less abundantly, and exists, forming veins, in serpentine, mica slate, and primitive lime-stone rocks.

*Amianthus*, the most delicate variety of asbestus, comes most plentifully from Savoy and Corsica. Its fibrous texture and the little alteration it undergoes in strong heats, caused it to be used by the eastern nations as an article for the fabrication of cloth, which, when soiled, was purified by throwing it into the fire, from whence it always came out clean and perfectly white. By the Romans, this cloth was purchased at an exorbitant price, for the purpose of wrapping up the bodies of the dead, previously to their being laid upon the funeral pile. The preparation of this cloth is effected by soaking the amianthus in warm water, rubbing it with the fingers, soaking the filaments in oil, when they are mingled with a little cotton, and spun upon the ordinary spindle. When woven into cloth, the fabric is heated red-hot, and the oil and cotton consumed, leaving only a tissue of pure amianthus. Paper may also be formed from this substance, in the way in which common paper is made, except that more size is requisite. A book has even been printed on such paper. Lamp-wicks have also been constructed from amianthus, but they require to be cleaned occasionally from the lamp-black.

In Corsica, it is used in the manufacture of pottery, being reduced to fine filaments, and kneaded up with the clay; the effect of which is to render the vessels less liable to break, from sudden alternations of heat and cold, than common pottery.

ASARABACEA, is a perennial plant, whose fresh leaves in fine powder are snuffed at bed-time, in doses of 3 or 5 grains for the relief of tooth-ache, headache, ophthalmia, &c. by copious discharge from the nostrils. The snuff is made by rubbing 3 parts of the leaves with 1 part of marjoram-leaves and lavender-flowers.

ASHES, the fixed residuum of a whitish or whitish-gray colour, which remains after the entire combustion of organic bodies, and is no longer able to support combustion. The constituent parts of ashes are different, according to the different bodies from which they originate. The ashes of vegetables consist chiefly of earthy and saline ingredients, the latter of which may be separated by washing, and are called *vegetable alkali.*

The more compact is the texture of the wood, the more alkali it affords. Some herbs, however, yield more than trees, and the branching fern the most. The more the plants have been dried, the less they produce. The vegetable alkali is always combined with carbonic acid. The greater, therefore, the heat by which the ashes are produced, and the more continued and powerful the calcination of the alkali, the more caustic will it be. It can only be entirely purified from foreign substances by crystallization. Of quite a different quality are animal ashes, particularly those obtained from bone. After calcination, it retains its original texture, and contains, besides lime, a peculiar acid, called *phosphoric acid*, as phosphate of lime.

The use of vegetable ashes is very extensive, as is well known. Soap-makers, bleachers and other tradesmen use them in an immense quantity. They are, also, an excellent manure.

ASHLAR, in building, is a coating of roughed or rough stones, fixed superficially at the back with cement, and intermingled with bond stones as ties and supports.

ASH-TREE. The ash (*fraxinus excelsior*) is a native of Europe and the north of Asia, and grows in a light marly or calcareous soil. The timber, which is nearly as good when young as old, is white, hard, and tough, and much used by coach-makers, wheel and cart-wrights, for ploughs, axle-trees, felloes of wheels, harrows, ladders, and other implements. It is likewise used by ship-builders, and by coopers for hoops. Where by cutting it is knotty and veined, it is used for cabinet-work. It burns better, while wet and green, than any other wood.

ASPARAGUS, is a well-known plant. It grows wild on the beach near Weymouth, and in Anglesea; not usually thicker than a straw, and its whole heighth does not exceed a few inches. It is one of the greatest delicacies of our kitchen-gardens. It is raised from seed or plants in beds, and the plants remain 3 years before they are cut; after which they continue to afford a 7 years' supply.

ASPIDIUM, or fern-root, an astringent anthelmintic medicine, fatal to the tape-worm, if from 1 to 3 drachms of the root in powder are taken in a tea-cup of water early in the morning, followed in 2 hours by a dose of calomel and gamboge, and this by some salts.

ASSAY-BALANCE; a very delicate balance, employed in determining with great precision the weight of minute bodies. It is used for assaying the precious metals in royal mints.

ASSAYING; is a species of chemical analysis, to ascertain the quantity of gold or silver in a metallic alloy. In its more extended meaning, it is used for the determination of the quantity of any metal whatsoever, in composition with any other metal or mineral. The assaying of gold or silver is divided into two operations; by one of which they are separated from the imperfect metals, or those easily oxydized; by the second they are separated from the metals which resist oxydation by simple exposure to the air, and which have, therefore, been called the *perfect metals*. This second process generally consists in separating gold and silver from each other, as the third perfect metal, platina, is seldom found united to them.

The method of separating gold or silver from the other metals, is founded on the facility with which the latter imbibe oxygen, and the process is calculated to accelerate this operation; hence the oxide of lead, or litharge, is generally considered as the most powerful purifier of the perfect metals, from the ease with which it parts with its oxygen to the imperfect metals united with them. But, of late, oxide of manganese has been found superior to it. In chemical analysis of metals, the oxide of lead is generally preferred for the above purpose; but, in the assays performed by order of government, metallic lead is always used, probably from the facilities which it is supposed to afford for determining the weight of different ingredients by calculation. The lead in the process first becomes oxidated, then yields some of its oxygen to the other imperfect metals, and afterwards becomes vitrified, in conjunction with the other oxydes so formed, and carries them off with it, leaving the perfect metals pure and separate.

The above operation is called the *cupellation*, and is performed on a flat round cake of bone-ashes, compressed within an iron ring, which is named a *cupel:* this is placed in a vessel called a *muffle*, which resembles a small oven, fixed in a furnace capable of giving a heat sufficient for the fusion of gold, so that its mouth may come in contact with the door, at the side to which it is luted, to separate it from the peal: there are small slits made in the sides of the muffle, to afford a passage for the air.

The article on *Analysis* mentions the use of the blow-pipe to detect certain fixed bases, &c. The student will find this indispensable, to ascertain their nature and habitudes; and as they are often connected, the following notices of the many and varying appearances of the assay, alone, or combined with fluxes, on supports of charcoal, metal, or glass, under the effect of the outer or inner flame, will direct his conclusions in reference to the results. When expense is disregarded, a series of ticketed mineralogical specimens are useful.

The assay never needs exceed that of a rape-seed, and it cannot be too thin, only the point of the flame acting on it; and olive-oil or water is used to form powders into a paste. The assay is tried on *supports*, which do not chemically combine with it. Small pieces of *Alder charcoal*, 4 to 6 inches long, are useful for oxides and metallic minerals; as a perforation upwards will retain the whole assay, and also the oxygen which facilitates the process.—Small slips of *platinum foil* enfold an assay, and unwrap after the process. Hooked *platinum wires*, 2 to 3 inches long, bear the flux to fuse into a globule, in which the assay is fixed by moisture, and all changes are very obvious. A small *glass matrass*, and an open *tube of glass*, 3 inches long, and $\frac{1}{8}$ diameter, will receive an assay, when volatile components not permanently gaseous are to be sublimed. A useful implement is a *pair of forceps*, with platinum points like ear-picks.

*Roasting* the assay in the glass tube, by heat, expels all the sulphur and arsenic; known when Brazil wood test paper does not bleach, neither is there an odour like that of garlic.

*Decrepitation* is prevented, by first heating the charcoal and introducing the assay gradually from the upper end, bringing the flame on it till red-hot. Or, place the assay either in a groove between two slips of charcoal, or in melted borax, platinum tube, or foil, matrass, or tube, on which direct the flame.

*Reduction.*—Metallic oxides, fused into a glass bead, the metallic particles form a globule, soda is added; the heat is continued, and in the inner flame all is absorbed by the charcoal; next cool by a drop of water. The assay is abstracted, ground fine in agate mortar, and by the dropping bottle carefully are washed away the soda and the charcoal.

The following *appearances* are constant:—The assay, *alone*, either *does* or *does not* in the matrass evolve water (to be tested) change colour—decrepitate—give off volatile matter, odourant of garlic, (by arsenic) or brimstone (by sulphur) or horse-radish (by selenium) or be mercury. And *on charcoal*, in outer, then in inner flame, evolve volatile matter, (as above) decrepitate—when roasted, be magnetic, melt—intumesce, or bubble—effervesce, or sputter—volatilize—colour the flame —burn—change colour—be absorbed by the support—fuse, and result, a bead, ash, globule, or enamel. And on charcoal, *with a flux*, fuse—intumesce—effervesce—change transparence—colour the flux—detonate—be absorbed—colour the flame—fuse, and yield a result as above.

A *Flux* added to the assay, assists its fusion; and in the *dry way*, or fire, has similar use to an acid, or an alcali, in the *humid way*. It acts chemically, in separating the acid of a metallic oxide from the base; in also dissipating the oxygen, and leaving the base pure. But mechanically when by it the compound agglomerates into a button.

The *three Fluxes*, for mineralogical chemistry, are thus prepared:—The BORAX, is common borax boiled a long time, evaporated, and in small crystals preserved, to be applied to *bits* of the assay (seldom to *powder*) by the moistened point of the knife. SODA (indispensable to discover minute portions of reducible metals,) is common subcarbonate in solution, and excess of nitric acid; by nitrate of barytes, separating sulphuric acid, and the muriatic, by nitrate of silver. The fluid evaporate, fuse, decompose with charcoal; wash the residue, crystallize the solution, and preserve the crystals. Or, dissolve subcarbonate in water, filter, slowly evaporate, skim off the small crystals, cool, crystallize, and preserve the crystals, to be used in fine powder, but in different proportions with silicious minerals, as a part may be absorbed by the charcoal support. MICROCOSMIC (or *Mic.*) SALT, (Salt of phosphorus, or phosphate of soda and ammonia.) Crystallize a solution of phosphates of soda, and (excess) of ammonia; (or, 16 parts sal ammoniac, and 100 phosphate of soda,) heat, filter, and preserve the resulting crystals.

When the assay is opaque, decrepitates long violently, the globule is unchanged on platinum foil, but on charcoal expands, crackles, and is absorbed; or, when on the platinum wire the bead fused by the inner flame gives a violet colour to the outer, the assay is POTASS. But when this is yellow, like that of a candle, SODA. And when at a red heat, the platinum foil is corroded, a dull trace of yellow left, and the flame is a beautiful carmine red, the assay is LITHIA (*red* only with potass; yellow with only soda.) AMMONIA entirely dissipates. Also, put the red-hot fragments of alcaline minerals on test paper, and round where they lie will be a blue stain.

When the assay alone, on charcoal or platinum, is not altered; but with borax effervesces, and fuses into a glass clear, but opaque, by flaming rendered milk white; also intumescing, with mic. salt, and with soda, absorbed; or a bit, held by platinum forceps, at the point of inner flame after some time gives a carmine red colour to the outer; it is STRONTIAN; when the flame is not red, it is BARYTES. The globule, with solution of pure nitrate of cobalt, red brown while hot, colourless cold, indicates BARYTES; but black, not melted, STRONTIAN. This in chloride, on platinum wire, at the point of the inner flame, causes the carmine colour, which ceases with fusion; (thereby distinguished from chloride of *lithia*, which is constant.)

When the assay alone, on charcoal or platinum, supplies an intensely-brilliant light, yet is unaltered; and, with borax forms a clear glass, opaque by flaming; or crystallize, when the base is in excess; less milky than with barytes or strontia; with soda, infusible; and with mic. salt easily fused into a transparent glass; or with solution of cobalt dark grey, infusible, the base is LIME. But when, with soda, no action ensues; with mic. salt the glass is clear but opaque, or milk white; and with solution of cobalt, a flesh red colour, cold by day-light; then it is MAGNESIA.

When the assay alone, on charcoal or platinum, is infusible, yet contracts; also, with borax, effervescing much, slowly fuses into a transparent glass, not opaque by flaming or cooling; or with soda, merely effervescing, expands, infusible; or with mic. salt violently effervescing, fuses into a clear glass, not opaque by saturation; or with solution of cobalt, dried, and in inner flame long heated, becomes a fine bright blue, cold by day-light; hot, or by other light, a dirty violet, and which becomes only more beautiful in proportion to the quantity of cobalt—the base is ALUMINE.

When the assay alone, on charcoal or platinum, is infusible, but with borax slowly melts, unefervescent, into clear glass not easily fused, nor opaque by flaming; or, with soda (or charcoal) effervescing fuses into a clear glass, or with mic. salt, and by long heat slowly and only partially dissolves, unefferves-cing, a portion swimming in the flux, a transparent inflated mass, the remainder semi-transparent, the glass permanently transparent; or with little cobalt pale blue, with much black, (thus known from alumine) the base is SILICA.

When the assay alone, on charcoal or platinum, is splendidly brilliant, yet infusible, and with borax or mic. salt dissolves, or fuses into a clear or transparent glass, milk white by flaming, or excess, not affected by soda, but with solution of cobalt becomes dark grey, or black, the base is either GLUCINA, THORINA, YTTRIA, OR ZIRCONIA, (proved by tests, on a precipitate, by a solution of potass, not re-soluble in excess.)

When the assay alone, on charcoal or platinum, is brown red, infusible, but, in inner flame, with little borax fuses to glass, yellow green hot, colourless cold, with much borax, when cold, crystalline enamel, white; in outer flame orange, or beautiful red hot; pale yellow cold, or, with mic. salt, the glass a fine red hot in outer flame, wholly disappearing in the inner, and colourless and clear cold, or not affected by soda, which is absorbed, and there remains (on the charcoal) a grey white powder, the base is CERIUM.

When the assay, treated as in the preceding process, in the outer flame bubbles, gaseous, and forms a glass of clear amethystine colour, in inner flame without bubbling lost, yet in outer reappearing, or with soda, on charcoal, is not reduced, but on platinum foil fuses into glass, clear green hot, blue-green cold; the base is MANGANESE.

When the assay alone, on charcoal or platinum, fuses, ignites in blue green flame and white vapour, or with borax enlarges, then lessens, the flux spreads on the charcoal, or with mic. salt flashes, crackles, and detonates, or as oxide, alone, on charcoal, yellow, then white, infusible, brilliantly ignited, and in inner flame white fumes, or with borax, or mic. salt, a clear glass, by flaming milky, or a white enamel, cold, or round the globule, in inner flame, on the charcoal white powder; similarly with soda reduced, or with solution of cobalt, a fine green glass, and with copper, the alloy *brass*; the base is ZINC.

When the assay alone, on charcoal, in outer flame oxidates black, and in inner reduces grey, infusible, or, a little with borax, or mic. salt, easily fuses into a transparent glass, blue, or, with much, black, yet red by transmitted light (the mic. salt violet,) or, with soda, on platinum, fuses partially, red hot, grey cold; or, on charcoal, in inner flame, without fusing, forms a grey powder; the base is COBALT.

When the assay alone, on charcoal or platinum, is infusible, (arseniate with soda only,) but, with a little borax fuses, becomes malleable and magnetic; or, the oxide alone, in outer flame is black, in inner greenish grey, or, with borax or mic. salt forms a dark red glass, lost when cold, in inner flame, black opaque, then grey and translucent, or, with soda, on charcoal, readily reduces to a white metallic powder; the base is NICKEL.

When the assay alone, on charcoal or platinum, oxidates, infusible; or, with mic. salt solely, fuses; or, as oxide alone, on platinum fuses, but, on charcoal, in outer flame is not altered, yet, in inner becomes black and magnetic; or, with borax, or mic. salt, in outer flame forms a glass, dull blood-red hot, or clear lighter yellow cold; or, in inner flame is green, lost when cold, magnetic, or with much borax forms a green glass, or with soda is absorbed and reduced into a dark-brown metallic magnetic powder; the base is IRON.

But, when the assay alone, on charcoal, forms an orange powder, or, with borax, or mic. salt, on platinum wire fuses into glass, clear or yellow hot, colourless or opaque cold, and on charcoal bubbles, reduces, and sublimes into a yellow powder; the base is CADMIUM.

When the assay alone, on charcoal or platinum, easily fuses, irridisces, boils, fumes, or as oxides alone, on charcoal, in outer flame becomes black, yellow, and orange, in inner flame is reduced to a yellow coating, then to metallic globules, easily flattened by the hammer, or, with soda, reduced immediately, slightly colouring the flux; or, with borax, on platinum wire easily, (mic. salt less easily,) forms a glass, yellow hot, colourless cold, the base is LEAD.

When the assay alone does not sublime in the glass matrass, but, on platinum easily fuses, or, on charcoal, in outer flame fumes, and a red mark remains, lost in inner flame, (as are the greenish blue of antimony, and the deep green of tellurium,) or, as oxide alone, on platinum, in outer flame readily fuses to a brown glass, fine cold; in inner reduces and perforates the support, or, on charcoal, fuses into metallic globules, brittle and refractory, or, with borax, in outer flame, a grey speckled glass, in inner decrepitates, reduces, and volatilizes, or, with mic. salt, brownish yellow hot, pale cold; the base is BISMUTH.

When the assay alone, on charcoal or platinum, by outer flame is not altered, but in inner fuses into a metallic globule, or with borax and mic. salt in outer flame fuses into a glass, fine green hot, blue green cold; in inner dirty brownish red, lost in charcoal; or with soda, on platinum wire in outer flame melts into a glass, fine green hot, colourless and opaque cold; or in inner, on charcoal, is reduced; the base is COPPER.

When the assay alone, on charcoal or platinum, easily fuses without oxidation, or with soda in inner flame is reduced to a white globule, or with mic. salt, in outer flame, an opalescent glass, red by candle-light, yellow by day-light, or grey in inner flame; or as oxide, alone, is readily reduced, or with borax is partially dissolved, partially reduced; in outer flame, a milky glass, grey in inner; or with mic. salt fuses, opaque and whitish yellow cold; the base is SILVER.

When the assay, in glass tube, with dry soda, iron filings, or oxide of lead, by a red heat reduces to a grey powder, or sublimes in the cold part, and by agitation is formed into globules; the base is MERCURY.

When the assay alone, on charcoal or platinum, is infusible, and not affected by any flux, yet by the cupel is reduced to a grey infusible porous metallic mass; the base is either RHODIUM, PALLADIUM, or IRIDIUM. (The first *soluble* in nitro-muriatic, the second in muriatic, the third in nitric acid.)

When the assay alone, gently heated, oxidates and volatilizes with a pungent odour, like that of chlorine, the base is OSMIUM.

When the assay alone, or with any flux, on charcoal does not oxidate, yet fuses without colouring the flame, or in a cupel leaves a grey malleable metallic globule, the base is PLATINUM.

When the preceding effects occur at a red heat, the base is GOLD.

When the assay alone, on platinum or charcoal readily melts, ignites, and oxidates, or, as oxide alone, on platinum in outer flame is yellow, then red, and in inner, ignited, is black, and, with soda effervesces without fusing; or, on charcoal, with soda or potass, in inner flame white, reduced easily to a metallic lead readily flattened by the hammer; but, with borax or mic. salt, difficult to fuse, and forming a glass, or which renders a copper bead no longer green, but opaque and brown red; the base is TIN.

When the assay alone, on charcoal, ignited, becomes dark brown, on platinum yellow without melting, or with borax, or mic. salt easily forms glass, white by flaming, in inner flame, dull amethystine; on charcoal dull yellow hot, deep blue cold; or with soda effervesces, and forms a yellow glass, from outer flame, crystalline, and in cooling evolving much heat; or with solution of cobalt, grey black glass; the base is TITANIUM.

When the assay alone, on charcoal or platinum, easily fuses, and ignited burn with white dense fumes, which around the globule form beautiful pearl-like crystals, or, as oxide alone, on charcoal easily reduces, with a green flame, and on platinum easily melts, or with borax, on charcoal, forms a transparent glass, yellow hot, lost cold; in inner flame grey, opaque, or with mic. salt, on platinum wire, in outer flame with borax, but with soda, in inner flame, reduces, and remains melted, and the white fumes are condensed reticular; the base is ANTIMONY.

When the assay alone, on charcoal or platinum, without smoke or fusion becomes yellow, brown, and black, or, with borax, on platinum wire, in outer flame (on charcoal in inner,) fuses easily to a colourless glass, opaque by flaming, or with mic. salt, in inner flame, a blue glass, more beautiful than with cobalt, lost in outer, recovered in inner, or, with soda on platinum wire, yellow translucent glass, when cold crystalline, opaque, and yellow, or, on charcoal, in inner flame reduces to a brilliant steel-grey metallic powder; the base is TUNGSTEN.

When the assay alone, on charcoal, is fused, absorbed, and reduced to grey powder, or, on platinum, melts in white fumes, in inner flame acidifies blue, in outer oxidates white, then brown, or, with borax, on charcoal, in inner flame, fuses, and black scales leave the glass clear, greenish, or, with mic. salt, in outer flame, a glass green, yellow, red, brown, and hyacinth, in succession, in inner, yellow-green, yellow-brown, brown-red, and black, or with soda, effervesces, a glass transparent, red, and paler cold; the base is MOLYBDENUM.

When the assay alone, on charcoal or platinum, with a green flame remains unaltered, or with borax, in outer flame forms a glass, bright yellow, or yellow-red; in inner, greenish, even when cold, or with mic. salt, in either flame, a glass emerald-green, (but copper, green in only outer,) or, with soda, on platinum wire, in outer flame, a glass orange hot, yellow and opaque cold; in inner, opaque green cold; absorbed, not reduced; the base is CHROMIUM.

When the assay alone, on charcoal, in outer and inner flame alternately, readily burns with a blue flame, and strong odour of garlic, or in glass tube with borax and charcoal powder, sublimes and deposits a crystalline or metallic result, the matter is ARSENIC, (ACID.)

When the assay alone, in a matrass, sublimes into a gray metallic powder, or, in open tube, a white, or on charcoal a green-edged blue flame, or, on platinum, melts and fumes, with the odour of putrid horse-radish, or, on charcoal, gently heated, becomes yellow, red, black, is fused, absorbed, and reduced, effervescing and detonating, or, with borax, or mic. salt, a glass on platinum wire clear, on charcoal grey and opaque, or with soda, on platinum wire, colourless hot, white cold; on charcoal, in inner flame reduced; the base is TELLURIUM.

When the assay, in an open tube, by outer flame sublimes into a red powder, the base is SELENIUM.

When the assay, with soda and silica, on charcoal in inner flame render the glass bead dark-brown hot, red cold, or with soda only, on charcoal, afterwards stains silver black or dark yellow, the matter is SULPHURIC, (ACID.)

When the assay, with borax, on charcoal, is fused and transfixed on harpsichord wire, then much heated in inner flame, (forming carbonate and phosphate of iron,) then the lead, cold, and in paper crushed, a grain of brittle magnetic metal appears, or the assay moistened with sulphuric acid, and by platinum forceps held in inner flame, thereby rendered green, the matter is PHOSPHORIC, (ACID.)

When the assay alone, on platinum, is not altered, but, with borax, a glass clear, transparent, opaque, or white-enamel, by flaming, or, with mic. salt, transparent, or, with soda, effervesces and combines, yet neither melts nor reduces, nor is blue with solution of cobalt, the base is COLUMBIUM.

When the assay alone, on charcoal, without fusing from yellow becomes black, or, with borax, in inner flame forms a greenish glass, with black specks, lost in outer flame by yellowish green or brown; then, in inner flame, green without specks; or, with mic. salt, on platinum wire, in outer flame, clear glass, yellow hot, greenish yellow cold; on charcoal, in inner flame, fine green hot, more beautiful cold, or, with soda, yellow brown, not dissolved or reduced, the base is URANIUM.

When the assay, added to the dark-green bead, formed of mic. salt and oxide of copper, gives to the whole flame a fine blue colour, or a greenish blue, or a superb emerald green, or a fine blue purple, the matter respectively is CHLORINE, BROMINE, IODINE, OR MURIATIC ACID, (rarely sought separately.)

When the assay, with charcoal, fuses and detonates, or without fusing evolves orange vapour, the matter is NITRIC ACID.

When the assay, with 1 part of fluor spar, and 4½ parts of bisulphate of potass, on platinum wire, at point of inner flame causes a green halo round the flame, the matter is BORACIC ACID.

When the assay, in open tube, with mic. salt (mica, &c. best in a matrass,) heated a little corrodes the glass, and evolves a peculiar odour, the matter is FLUORINE, OR FLUORIC ACID.

Attention to the appearances will preclude every possibility of error or mistake.

ASTRALAGUS, or Tragacanth, is a Persian shrub which spontaneously yields a gum that drys on the plant; much employed in pharmacy, and useful in relieving coughs. It requires trituration to form aqueous mucilage.

ASTRINGENTS, are substances which contain the tannin principle, as catechu, quinine, bark, gall-nuts, &c.

ATTAR OF ROSES. Ghazedpon is celebrated throughout India for the extent of its rose-gardens, occupying many hundred acres. The price of 2 lbs. weight of the best rose-water is a shilling. The attar is obtained after the rose-water is made, by setting it out during the night, until sunrise, in large open vessels, exposed to the air, and then skimming off the essential oil. To produce half an ounce of attar, 200,000 well-grown roses are required. An ounce is sold on the spot for £8, and at the English warehouse for £10 sterling. If grown and made it costs £5 per oz.

ATOMIC THEORY. Nothing is more certain than that all matter consists of parts which, by trituration, may be reduced smaller and smaller. But though these are the atoms of vulgar observation, they are not so of the philosopher or chemist. He finds that, however small, they retain distinctive qualities and relative powers; and the cause of these differences, or the nature of the atoms which produce them, is the object of his researches. The cause of the difference between a particle of gold, visible only to the microscope, and another particle of charcoal, is the object of Atomic Philosophy.

This fact, first developed by Higgins, an eminent chemist, of Dublin, has been so followed up by Dalton, Fourcroy, Chaptal, Davy, Thompson, and other chemists, that we now know the numbers or ratios of the number of atoms, or the ratios of the weights of the constituents of several hundred compounds. The following tables give the numbers or proportions in which the several substances form compounds, and the several numbers of the principal substances are of such frequent recurrence in all the arts of life, that they ought to be familiar to the memory. The whole have been determined by experiment, examination, and analysis, but chemists differ in the results by small fractions.

The tables require an attention to *terminal nomenclature*, wisely adopted to avoid tedious circumlocutions.

*Ous*, is an acidity in one degree.

*Ic*, in the highest degree.

*Hyp*, prefixed, means between both, or lower than one degree.

*Deut*, is double,—*tri*, triple.

*Ites*, are salts in the first degree.

*Ates*, salts in higher degrees.

*Et*, any compound not a salt.

*Prot*, or *proto*, the lowest degree.

*Per*, or *pero*, several degrees.

*Super* and *bi* are prefixed to acid salts.

*Sub* to salts with the base in excess.

The ratios, or equivalents, or relative weights of the following principal bodies or gases, are usually taken as under:—

| | |
|---|---|
| Hydrogen | 1 |
| Carbon | 6 |
| Oxygen | 8 |
| Carburetted Hydrogen | 8 = 6 + 2 |
| Water | 9 = 8 + 1 |
| Phosphorus | 12 |
| Nitrogen or Azote | 14 |
| Carbonic Oxide | 14 = 8 + 6 |
| Sulphur | 16 |
| Silica or Silex | 16 |
| Ammonia | 17 |
| Sulphuretted Hydrogen | 17 = 16 + 1 |
| Magnesia | 20 |
| Carbonic Acid Gas | 22 = 16 + 6 |
| Nitrous Oxide Gas | 22 = 14 + 8 |
| Alumina | 26 |
| Cyanogen | 26 |
| Cobalt | 26 |
| Cyanuretted Hydrogen | 27 = 26 + 1 |
| Lime | 28 |
| Iron | 28 |
| Phosphoric Acid | 28 |
| Manganese | 28 |
| Sulphurous Acid | 32 = 16 + 16 |
| Soda | 32 |
| Zinc | 34 |
| Chlorine | 36 |
| Oxalic Acid, crystals | 36 |
| Muriatic Acid | 37 |
| Hydrate of Lime | 37 |
| Arsenic | 38 |
| Sulphuric Acid | 40 = 16 + 24 |
| Antimony | 44 |
| Nitrous Acid | 46 |
| Potash | 48 |
| Carbonate of Lime | 50 |
| Acetic Acid | 50 |
| Carbonate of Soda | 54 |
| Nitric Acid | 54 |
| Phosphate of Lime | 56 = 48 + 8 |
| Tin | 57 |
| Citric Acid | 58 |
| Crystals of Acetic Acid | 59 |
| Phosphate of Soda | 60 = 32 + 28 |
| Sulphate of Lime | 60 = 32 + 28 |
| Arsenic Acid | 62 = 38 + 24 |
| Copper | 64 |
| Crystals of Tartar | 67 |
| Carbonate of Potash | 70 |
| Bismuth | 72 |
| Chloric Acid | 76 |
| Baryta | 78 |
| Per-Chloric Acid | 92 |
| Platinum | 96 |
| Lead | 104 |
| Chlorate of Lime | 104 |
| Silver | 110 |
| Benzoic Acid | 120 |
| Iodine | 125 |
| Iodic Acid | 165 |
| Gold | 200 |
| Mercury | 200 |

The substances form chemical compounds only in the above proportions.

To determine the atomic proportions in a compound, the proportional weight of whose constituents are given, divide the weights of the constituents by the weight of each, and the quotient is the ratio of the atoms.

The Atomic Theory of the combination of elements and bases, in definite and unchangeable proportions, is one of the most important discoveries of modern times. It forms no clue to the forms or mode by which the atoms unite; but since the union is arithmetical, we may conclude that it is altogether mechanical, and governed by reciprocal facilities of moving and filling the space. It seems to be a law of nature, arising from action and re-action, that every equal space should contain equal power, and this law seems to govern the atomic motions. Of course, it applies only to atoms in motion, fixed or concrete bodies having no action on each other, and fluidity, or gassification, in at least one, is necessary to any phenomenon. A dry acid or dry alkali would lie side by side, for years, without change, except so far as the aura, or effluvia, or the humidity of the atmosphere, might create an action and reaction.

The motions, whether in fluids or in gases, are believed to be circular, or orbital, owing to reaction on a rectilinear force, which necessarily produces an orbit. Whether atoms unite in one orbit, or circulate in concentric circles, or in continuous rings, or in planes parallel, or at right angles, we have at present no data on which to conclude. But this is certain, that definite quantities fill a space, that bulk is as excitement, and that if any disorder arose in any place, the reaction of the atoms in all space would concur to restore an equal force in an equal space, and a compatible regularity of motion.

Our concentrations, no doubt, arise from containing vessels, and by them we often localize forces that do not belong to nature, but seek diffusion with the usual law of equality in equal spaces. Hence our stopper-bottles, &c. &c. and hence, in fine, our electric and galvanic restorations.

The atoms of various primary bodies, called by chemists elementary, are, to each other, by weight, in the proportion of the following numbers, which should be well remembered, at least ten or twelve of them.

*Gases, either simple or compound, which support combustion.*

| | |
|---|---|
| Oxygen | 8 |
| Chlorine, or oxymuriatic gas | 36 |
| Bromine | 80 |
| Iodine | 126 |
| Fluorine | 18 |

It is not to be believed that either is simple besides oxygen, but this is the technical classification of modern writers on chemistry.

*Gases and Substances which, when united to supporters, are acids.*

| | |
|---|---|
| Hydrogen | 1 |
| Nitrogen | 14 |
| Carbon | 6 |
| Sulphur | 16 |
| Silicon | 8 |
| Phosphorous (15·71) | 16 |
| Boron | 8 |
| Selenium | 40 |
| Tellurium | 32 |
| Arsenic | 38 |
| Antimony | 64 |
| Chromium | 32 |
| Vanadium | 68 |
| Molybdenum | 48 |
| Uranium | 208 |
| Tetanium | 26 |
| Colombian | 182 |
| Tungsten | 100 |

The list is given as found in works of chemists of authority; but it should be remarked, that several of them are mere curiosities of the laboratory, and often forced into nature by the personal vanity of the discoverer. The numbers, in relation to the acknowledged simple bodies, prove, at sight, the absurdity of considering them simple bodies. Even nitrogen stands too high for simplicity. We might, with little hazard, exclude all from the elementary character, except hydrogen, oxygen, carbon, and its varieties, silicon and boron. Analysis, however ingenious, is palpably imperfect.

Some other substances merit place.

*Dry Alum* is 3 sulphate of ammonia, 174, and 1 sulphate of potassa, 88, = 262.

To crystallized, 25 of water is added, making together 487.

*Carbonate of Lime* is 1 lime, 28, and 1 carbonic acid, 22, = 50.

*Phosphate of Lime* is 28, and 1 phosphoric acid, 35·71, = 63·71.

*Sulphate of Lime* is 28, and 1 sulphuric acid, 40, = 68.

*Ammonia* is 1 nitrogen, 14, and 3 hydrogen, = 17.

*Cyanogen* is 2 carbon, 12, and 1 nitrogen, 14, = 26.

All these numbers are determined by the ratio of 8 oxygen to 1 hydrogen, in water. Some consistency would result from taking it 16 and 2, but some take it decimally, as 10 to 1·25. Others 100 to 12·5, and one eminent chemist as 200 to 25, *i. e.* 8 to 1 in every case. The higher it is taken the fewer the fractions in the compounds.

It should be borne steadily in mind, by uninitiated readers, that all natural and perfect compounds are made in these precise weights, or in some multiple of either, or both, *i. e.* in strict mechanical union. Thus 8, 16, or 24 oz. or lbs. of oxygen may combine with 64 or 128 oz. or lbs. of antimony, or with 16 or 64 of phosphorus.

Aluminum .............. 10

This metal forms the earth alumina (18) the metal with one dose of oxygen.

In this class five other peculiar products of the retort are added, but utterly unworthy of notice.

The metals are,—

| | |
|---|---|
| Copper | 32 |
| Iron | 28 |
| Lead | 104 |
| Zinc | 34 |
| Tin | 58 |
| Manganese | 28 |
| Nickel | 26 |
| Cobalt | 26 |
| Cadmium | 56 |
| Bismuth | 72 |
| Mercury | 100 |
| Silver | 110 |
| Palladium | 54 |
| Rhodium | 54 |
| Iridium | 98 |
| Osmium | 100 |
| Gold | 100 |
| Platinum | 96 |

Reasoning by analogy, from what we know of potassium, calcium, soda, &c. and considering these metals to be variously constructed of nitrogen, carbon, silica, borax, &c. (preferring those of readiest union) we may easily compose all these numbers. Thus, Copper would be 1 nitrogen, 14, 3 carbon, 18; Iron 1 N. 14, 1 carbon, 6, 1 silica, 6; Lead 7 N. 98, 1 carbon; Zinc 2 N., 1 carbon; and Tin 3 N., 2 silica.

The difference of the earth would depend on the rocks whose galvanic action, in the veins or dykes, generated these compounds, and whose aura, conveyed by the acid and alkali of electrical action, served through countless ages, as the generic base of each metal.

Some of the numbers may even be made up of the alkalies, but that they are made up in one of these ways, and by silent electrical action in long duration in the spaces or interstices of rocks, there cannot be a reasonable doubt.

For the numbers given above, the world are indebted to the accurate researches of Dalton, Davy, Henry, Thompson, Prout, Berzelius, Chaptal, Vauquelin, Fourcroy, Guy Lussac, Thenard, Klaproth, and other distinguished experimentalists of our own age.

*Substances which, when united to the five first, form alkalies, or, as to the atmosphere, neutral earths, are—*

| | | |
|---|---|---|
| Potassium .... | 40 | (Potash 48) |
| Barium ...... | 68 | (Barytes 76) |
| Sodium ...... | 24 | (Soda 32) |
| Calcium ...... | 20 | (Lime 28) |
| Magnesium .. | 12 | (Magnesia 20) |
| Lithium ...... | 6 | (Lithia 14) |
| Strontium .... | 44 | (Strontian 52) |

Hence, it appears, that, to form the fixed alkalies, one dose of oxygen (8) is imparted to the metals in each case.

If we suppose the base to be a compound of nitrogen and of carbon, or silica, then the conversion of the metals into alkali is the addition of one dose of oxygen. And the conversion of the alkali into metal is the abstraction of the oxygen and the substitution of one hydrogen in its place, as the means of its combustion as metal.

Then potassium would be 2 nitrogen, 28, 2 carbon or silica, 12, = 40.

Barium, a stronger alkali, 4 nitrogen, 56, 2 carbon or silica, 12, = 68.

To which, unless hydrogen be a constant constituent of nitrogen, 1 would be to be added, to account for the combustion and the fixation of oxygen by the metal.

Chemists mystify themselves by explanations about oxygen making the alkalies, forgetting that the oxygen superadded merely balances the oxygen in the atmosphere, and enables the alkali to subsist without further neutralization.

The metallic state is more alkaline, but no substance displays either acid or alkaline qualities in the fixed solid form, and we know the alkaline character of these metals, as soon as the fluid activity is superadded.

Under these circumstances, just theory should remove metals from the class of simple bodies.—*See* POTASSIUM.

Such are the doctrines of the modern school of chemistry, with such observations on them as may lead the reader, on these principles, to reason on them; but other views present themselves to the Editor, which he submits with deference, and allows to stand on their own merits.

The numbers used in the following arithmetical analysis, are to be found in Dr. Ure's Chemical Dictionary, page 468, second edition. They are also to be met with in other works, and are standards which may be relied on.

1. *Hydrogen*, in 100 cub. inch., weighs 2·118 grains, which is one-sixth of carbonic vapour or $\frac{carbon,}{6}$ = 12·708; then, in asserting its volume in space, hydrogen has six times more atomic velocity than carbonic vapour, *i. e.* 6 hy. = 1 c. v. in nature.

2. *Carbonic Vapour*, 12·708 grains + 2 hy. × 2·118 = 4·236 = 16·944 grains in 100 of *sub-carbonate of hydrogen.*

3. *Steam of Water* is 14·68 grains to the 100 cubic inches, and 100 water is 25252; hence it is expanded 1720 times; and, in relation to air, 30·519 grains water is compressed 827·38 times. Hence steam of water, to displace air, has above twice the force of air. Steam 14·68 × 2 + hy. 2·118 × 2 = 33·996, which accords both with sulphur and oxygen. By 2, we see that 2 carbonic v. 25·416, and 4 hyd. are 33·888, the exact specific gravity of oxygen and sulphur. The latter points to sulphur, and fully accords with its phenomena; while the former, steam and hydrogen, are either oxygen and hydrogen, or oxygen is their product, just as we consider either anterior. The composition of sulphur is more interesting.

4. *Ammonia*, 18 grains to 100 cubic inches, is evidently half nitrogen 14·825, and 1½ hydrogen, 3·177, = 18·002.

5. *Phosphorus*, 25·42, is ammonia, 18·002, and ¼ nitrogen, 7·4125, or 25·4127. Or it is 2 carbonic vapour, 25·416; or by 1, 1 carbonic vapour and 6 hydrogen is also 25·416, both of them such compounds as might constitute phosphorus without the absurdity of calling it an element.

6. *Sub-phosphuretted hydrogen*, 27·47, is of course phosphorus, 25·42 + hydrogen 2·118, = 27·538; the difference of a sixteenth may arise from error in analysis.

7. *Phosphuretted Hydrogen Gas*, 29·65 is palpably phosphorus, 25·42 + 2 hy. 4·236, = 29·656 exact.

8. *Carbonic Oxide*, also 29·65, appears to consist of 6 hydrogen 12·708, and subcarbonate of hydrogen 16·944, = 29·652. Carbonic oxide is a very absurd term.

9. *Carburetted Hydrogen*, also 29·65, is 2 carbonic vapour 25·416, and 2 hydrogen 4·236, = 29652.

10. *Nitrogen Gas*, also 29·65, is 100 cubic inches of carbonic vapour 12·708, and 100 of sub-carbonate of hydrogen 16·944, = 29·652. These 4 at 29·65 evidently have equal power in space, and the identification of the last with 2 volumes of hydrogen, accounts for an immense variety of chemical and electrical phenomena.

11. *Prussic Acid Gas*, 28·59, is made

up of 100 cubic inches of ammoniacal gas, 18·002 + 500 hydrogen 10·59, = 28·592.

12. *Deutoxide of Nitrogen*, 31·77 is equal half volumes, or 50 cubic inches of nitrogen 14·826, and oxygen 16·944, = 31·77.

13. *Oxygen Gas*, of which 100 inches is 33·888, is composed of 2 sub-carbonate of hydrogen concentrated 16·944 = 2 × 33·888, *i. e.* 2 carbonic gas 25·416 + 4 hydrogen 8·472, = 33·888.

Such, on the evidence of figures, and of such figures, being the fact, it is plain that the elements of nature are hydrogen and carbon, and though oxygen by its constitution may from its exactly treble dose of carbon be a supporter of combustion, and in its compound the cause of acidity in other bodies, yet it must in reason be regarded as the compound described.

14. *Atmospheric Air* can no longer, therefore be regarded as a compound of 400 nitrogen, 100 oxygen. 100 cubic inches are 30·519 grains, then 4 nitrogen are 118·608 + 1 oxygen 33·888, = $\frac{152\cdot496}{5}$ = 30·499, or 0·02 allowed for aqueous vapour, &c. But referring back to the constituents of oxygen and nitrogen, 500 of atmospheric air is 6 carbonic vap. 76·248, 4 sub-carbonate of hydrogen 67·776, and 4 hydrogen 8·472, which added are 152·502, and divided by 5 gives 30·5004 grains, as the weight of 100 cubic inches of air so composed.

15. *Sulphuric Gas*, which like oxygen is 33·888 grains, is $2\frac{1}{2}$ hydrogen 5·295, and 1 prussic acid 28·592, = 33·887, or we may prefer the constituents of prussic acid, 1, ammoniacal gas 18·002, and 5 hydrogen, very probable constituents of so combustible and volatile a substance as sulphur. Instead of ammonia we may write $\frac{1}{2}$ nitrogen and $1\frac{1}{2}$ hydrogen, or take half the constituents of nitrogen.

16. *Sulphuretted Hydrogen Gas*, 100 cubic inches of which are 36·006 inches, is sulphur 33·887 + hydrogen 2·118, = 36·005.

17. *Muriatic Acid*, 39·183, is oxygen 33·888, and $2\frac{1}{2}$ hydrogen 5·295, = 39·183. It may also consist of sea salt, manganese and sulphuric acid, but these would resolve themselves as above.

18. *Carbonic Acid*, 46·596, is plainly carbonic gas 12·708 and oxygen 33·888, or we may refer to the constituents of oxygen, and call it 3 carbonic vap. 38·124, and 4 hydrogen, 8·472, = 46·596.

19. 100 *Cyanogen*, 55·07, is 300 carbonic gas 38·124, and 100 S.C. hydrogen 16·944 = 55·078.

20. 100 *Chlorine*, 76·25 grains, is 100 oxygen 33·888, 100 sulphur 33·888, and 4 hydrogen 8·472, = 76·248, or we may take the constituents of sulphur and oxygen.

This arithmetical resolution and composition might be extended in like manner to every known gas with the same wonderful and unerring precision. The agreement to fractions carries the results beyond all allegation of chance, and the undeviating accordance renders it the most unquestionable theory ever promulgated.

The several weights have been determined by careful experiment, and such has been the past simplicity on the subject, that a few of the figures were calculated wrong in Dr. Ure's table, yet he set them down evidently without any suspicion that one fraction was preferable to another.

It may be objected that mere weights are no test of chemical agency, and that mixing given weights of any inert substances could not be admitted as proof that the compound consisted of those substances. This, however, has not been done; the primary agents are hydrogen, the most energetic of gases, which mingles with every thing, and carbon, a neutral and convertible substance, which absorbs many of its own volumes of most of the gases. Then it so happens that the numbers are fixed, and their composition into such odd weights as 29·65 of nitrogen, and 33·888 of oxygen, and in all is not fanciful or forced, but matter of plain fact. The weight of 100 inches of hydrogen is determined by independant experiment 2·118 by one chemist, and another determines nitrogen, &c. to 29·65. But it appears that this is 14 times the former. So with carbonic gas; it appears to be exactly 6 times that of hydrogen, and the 2 appear to make up 29.65, a coincidence of whose truth the probability is many millions to one. This repeated in every instance becomes powers of those millions, and a higher approach to absolute truth than is to be found in all science.

The cube root of 100 cubic inches is 4·6416 inches in each dimensions, so that in this space is contained gaseous matter subject to weight as 2·118 in hydrogen, 29·65 in 4 gases, 33·888 in 2, 216·7 and 252 in 2 fluoborates, 25252 in water, and 3434272 mercury. The last is 1,620,000 more than hydrogen, while water is 11922 more.

Yet hydrogen fills the space, and would maintain its cube of 4·6116 inches, even though mercury were intruded. As long as it is hydrogen, its 2·118 of matter would have power to assert its dimensions equally with the 3434272 of mercury. We might extend this to platinum, and increase the number one half, but neither water, mercury, nor platinum are gases.

Nevertheless, there is no miracle of superstition so great as that 2·118 grains of matter fills and asserts a space equally with 5 millions of grains, and there is no escape, but by adding motion to the atoms of hydrogen. Motion is the only power by which they can assert such space, and if motion regular, that is, in circular orbits. For in whatever confusion might be primary motions, the result of rectilinear motion and resistance must be orbital.

If, then, we add to 2·118 of matter 47·21432 of motion, we fill 100 cubic inches with equal power to that of adjoining space.

So in the 4 gases whose specific gravity is 29·65, by superadding 1–14th of the velocity, or 3·37267, we get the momentum by which they are able to fill a space.

In atmospheric air 30·519, we require motion equal to 3·276645 to enable it to fill 100 cubic inches.

In oxygen and sulphur gases 33·888, we require 2·9502 of motion to fill 100 cubic inches with the power of hydrogen.

In chlorine 76·25 of matter requires 1·3114 of motion in like manner.

While the densest fluoborate 252 indicates but 0·397 of motion, or the 120th of that of hydrogen.

100 cubic inches of ether, the lightest fluid, contains 15969 grains, or 62 times more atoms than the fluoborate, with 62 times less motion, or only 0·0064 of motion, and therefore is a fixed fluid.

These speculations might be carried further, and made to illustrate the limits of gassification and fluidity, as well as many other points in which enquiry has been mystified.

But after all a question arises whether great lateral motion does not diminish specific gravity, so that specific gravity is not on that account a test of the number of atoms in a space.

Something too may depend in the reactions of active agencies, as alkalies and acids on the direction of the planes of motion. Every practical chemist is aware that experiments and changes are often as sudden as the turning of a venetian blind, and this may arise from relative changes in the working direction of the atoms.

All these are points foreign to the present work, and alluded to merely *en passant*. It is so far a speculation that it is not pretended that the compounds have yet been made in these ways, for concentration of volume is necessary; it is merely shown that such are the fundamental proportions, and therefore that, in fact, hydrogen is the element or constituent atom of nature.

When we speak of carbonic gas as 6 hydrogen, we mean that 6 hydrogen atoms are united so as to form a new substance, after the manner which Wollaston has pointed out, and then form this gas which in 100 cubic inches has nearly 8 of motion, or a 6th of that of hydrogen; so in oxygen, 8 forms an octahedron, and in nitrogen 14, and these aggregates are then the atoms of carbon, oxygen, and nitrogen, and so of others. Subjected to motion they perform the functions of each compound.

Haüy, Beudant, and Wollaston have beautifully illustrated the entire subject. Hence we get 6 hydrogen and then in the sub-carbonate we get another substance in 8; but when attention is turned to the subject, there is no doubt that every degree of required concentration may be in possession of the chemist, so as to enable him to make up 100 cubic inches of any required compound by simple mixtures.

Chemists who may feel any difficulty about this condensation, should not forget the theoretical condensation of oxygen and hydrogen, whose mean is 12·708, but yet forms water of 25252. But it is not necessary to do more than combine some of the heavier and lighter gases to produce the mean density of the others.

And in pursuing these considerations it is impossible not to infer that the atmosphere is the necessary product of the water, land, vegetation, and organization on its surface. The proportions of water to land are 726 to 274, or 121 to 45, nearly; then in the atmosphere weight for weight, nitrogen is to oxygen as 118·6 to 33·888. Salt water, fresh water, vegetation, and carbonaceous bodies are palpably therefore the sources of our nitrogen and oxygen. The activity of the sea, and the inertness of land in the Polar regions would give an excess to the nitrogen. It is at the same time as easy to believe that muriatic acid is one of the bases of nitrogen, as that nitrogen itself is the base of nitric acid. No person can doubt but that we are indebted for the atmosphere to the intense motions of the earth, and therefore it must be the product of the parts.

The Editor is fully aware of the singular novelty and importance of these doctrines, and of their interference with ten thousand pre-conceived opinions, sustained by the ablest of men; he yields, however, to the unerring force of figures, and venturing to sow the seeds of truth, yields the enjoyment of their harvest to after-ages.

Atomic Mobility. — M. Muncke has published the following easy mode of showing the motions of particles or atoms. Triturate a piece of gamboge, the size of a pin's head, in a large drop of water on a glass plate; take as much of this solution as will hang on the head of a pin, dilute it again with a drop of water, and then bring under the microscope as much as amounts to half a millet-seed: there are then observable in the fluid small brownish yellow, generally round (but also of other forms) points, of the size of a small grain of gunpowder in distances from one another of 0·25 to 1 line. These points are in perpetual slower or quicker motion, so that they move through an apparent space of 1 line, in from 0·6 to 2 or 4 seconds. If fine oil of almonds be employed in place of water, no motion of the particles takes place, while in spirit of wine it is so rapid as scarcely to be followed by the eye. The idea of vitality is quite out of the question. If the diameter of a drop is placed at 0·5 of a line, we obtain, by magnifying it 500 times, an apparent mass of water of more than a foot and a half the side, with small particles swimming in it; and if we consider their motions magnified to an equal degree, the phenomenon ceases to be wonderful. The motion of atoms, in all fluids and gases, was explained by Sir R. Phillips in 1815, as necessarily circular or orbital, and very small atoms in a fluid display this motion of primæval atoms.

Brown, in England, has applied microscopes to all kind of substances, and found universal motions.

ATROPA or Belladona, or deadly night-shade, is a common plant which flowers in June, and produces berries in September, of a purple colour, affording juice of a violet colour, and sweetish. It yields *atropia*, an alkaline poison of great potency, made by boiling the leaves, and treating the decoction with sulphuric acid, potass, muriatic acid, and ammonia. The powdered leaves are administered in doses of 1 to 12 grains in cancer, hydrophobia, gout, epilepsy, and paralysis.

ATROPHY, is a deficient nourishment of the body. There are many diseases in which the body becoming daily more lean and emaciated, appears deprived of its common nourishment, and, for that reason, of its common strength. It is only, therefore, in those cases in which the emaciation constantly increases, that it constitutes a peculiar disease; for when it is merely a symptom of other common diseases, it ceases with the disease, as being merely a consequence of great evacuations, or of the diminished secretions or imperfect digestion of the nourishment received. But, when emaciation or atrophy constitutes a disease by itself, it depends upon causes peculiar to this state of the system. These causes are, permanent, oppressive and exhausting passions, organic disease, a want of proper food or of pure air, exhausting diseases, as nervous or malignant fevers, suppurations in important organs, as the lungs, the liver, &c. Copious evacuations of blood, saliva, semen, &c. are also apt to produce this disease, and, on this account, lying-in women and nurses, who are of slender constitution, and those who are too much addicted to venery, are often the victims of this complaint. This state of the system is also sometimes produced by poisons, *e. g.* arsenic, mercury, lead, in miners, painters, gilders, &c.

A species of atrophy takes place in old people, in whom an entire loss of strength and flesh brings on a termination of life without the occurrence of any positive disorder. It is known as the *marasmus senilis*, or atrophy of old age. Atrophy, too, is of frequent occurrence in infancy, as a consequence of improper, unwholesome food, exposure to cold, damp or impure air, &c. producing a superabundance of mucus in the bowels; worms, obstructions of the mesenteric glands, followed by extreme emaciation.

ATTORNEY, is one who transacts legal business for another, for which he is licensed by the courts of law. The intricacy of practice and of law renders them of such importance to the interests of their clients, that they obtain an undue ascendancy, and too often, in spite of their obvious profit in promoting suits, direct and controul their clients, instead of being mere agents of their wishes. Hence the principles of religion and morals are practically subordinate to the interests of this profession, and, under the plausible pretext of securing the interests of credulous and ignorant persons, they aggravate the cares and embitter the relations of life. The Courts punish flagrant misconduct; but, owing to the difficulty of proof or want of power, ten thousand wrongs are inflicted for one which is, or can be, punished. The only public protection would be to renew their admission every three years, under formal certificates of good character from local authorities, neighbours, or clients. Unrestrained as they now are, too many of them are the pests of society, and these extend a character of ignominy to the truly upright practitioners. A society has been formed to correct these evils; but, as unauthorized truth is a libel, so its operations have been of little service to the public.

ATTRACTION, is an effect of the motions or of the actions and forces in which bodies or atoms are involved; and, to understand nature and phenomena, it is necessary to examine all the circumstances in which a body is placed. This enquiry is generally dismissed by asserting that attraction is a property of matter; but, as there are various degrees and kinds of this mutual force, these imply several properties of attraction, while attraction would, in every case, be a miraculous power of matter, and a miracle, in many cases, without sufficient importance in the circumstances to render a deviation from the usual laws of nature necessary.

Every body remains at rest, unless a force is applied to move it. Every body moves in the direction of the moving force. And every body in motion, in any direction, affords evidence, by its motion, that it has been moved or is still moved, by some force acting in the direction in which it moves; that is, from the contrary side to the parts towards which it is moving. If, for example, it is moving from north to south, the moving force must have been, or must be, on the north side, that is, on the contrary side to the south side, towards which, the body is moving. In other words, a man cannot *push* another towards himself, because the force of a push must be from the opposite side.

For this reason, no two bodies can move each other towards itself, because the forces which make them approach must be on their opposite sides, where neither of the bodies is, and therefore not in force or power. Added to which, while they are going together, each is actually in force in the contrary direction to that direction in which the other is moving.

Then it is matter of fact, that they move inversely as their mutual quantities of matter, of which quantities neither is or can be cognizant. If a cork and bung, floating on water, are four inches apart, and the bung is three times larger than the cork, it will move exactly over one inch, and the cork, of a third its size, will move over three inches; each exactly apportioning its momentum to that of the other. This could not be done even by sentient beings, and not with the same precision by two philosophers. The cause therefore is palpably mechanical, or the product of quantity into velocity.

Again, two bodies on a balance, or in a pair of scales, exactly apportion their downward force or weight (its measure) to the number of atoms which they contain; or two bodies over a pulley do the same, with a precision that calculates to the smallest fraction, and they are not cognizant, sentient, or mathematical.

It is evident, that in each case the bodies are subject to some common force, or patient of some external equal force, which affects each exactly as its reaction. For a common force, greater than that displayed by the cork and bung, operating on each, would, by their reactions, exactly produce motions inversely as their quantities of matter.

And so with bodies in downward motion towards the earth, a common force would give to each a force of weight exactly as the number of atoms in each.

By a false analogy, as men see bodies drawn by ropes, by ropes and pullies, by muscular contractions, by horses in a carriage, &c. so the cork and bung, falling bodies, &c. are said, without consideration, to be drawn; but for this inference there is not a shadow of reason, since there are no ropes, or ropes and pullies, no muscular contractions, &c. to effect the drawing, and the idea of drawing is therefore altogether poetical, and a palpable mistake.

Bodies going together are, therefore, not pushed by the forces of each on the opposite sides of each, where they are respectively not present; and they are not drawn, since there is no tackle for the purpose.

Yet, as matter of fact, such motions do occur.

To account for them we must look around them. The cork and the bung, placed on water, exhibit their bulks out of it, and suffer little friction. The part out of the water is in the elastic atmosphere, which presses on all sides with a force of 15 lbs. to the square inch. The cork suffers 15 lbs. and the bung 15 lbs. This pressure proceeds from every point of the horizon; but when each are opposed at the distance of four inches, each intercepts the pressure in that direction on the other, while the pressure is unintercepted all round, except in that direction. Hence the small diminution on that side, and the perfect pressure on the opposite side drive them together. It is a common force, and their reactions are as their quantities; hence, their momenta being equal, their motions are inversely as their quantities. And, that this is the true cause of this and of a hundred phenomena of like kind, is made evident by an *experimentum crucis*:—Take a bung and cork, made of elm, or beech, or oak, which do not float *above* the water, or in the air, and place them at four inches, three inches, or even one inch, apart, and they will never go together, though they contain three or four times the matter in an equal bulk of cork, and they ought, by the alledged law of attraction, to exert three or four times the force of cork on each other.

Then, with reference to the downward force, or central force, of unsustained bodies, and the pressure of sustained ones, we have to reflect that we live upon a globe, in great motion, that is, in two *simultaneous* motions, one in the orbit 64·35 times greater than the *deflective* motion of rotation—that the centre alone moves with equal pace, the rest being turned aside by the rotation, 1—but sought to be brought back by the *undeflected* motion of the centre, 64·35. Then, the two motions being 98,065 feet per second and 1524 nearly in the equatorial circle, and the whole rotation in a sphere being four times 1524, so $\frac{98065}{6096} = 16·08725$ feet, the true mean fall of a body in a second. Or, taking the whole perpendicular deflection in a second as 970·216 feet, and this, owing to the balance of the sides, being the deflection through the sphere, on multiplying it by the circle, 6·283, we get 6096 as the deflective force, and the same result. It is, therefore, palpable, that the fall of bodies is exactly effected by the two motions; and it is the same for all parts of the same sphere, because the returning force is resolved into the sines and cosines, whose constant diagonal is the equal radius.

This knowledge might be found elsewhere, in other works of the Editor, but as it is one of the arts of life to get rid of superstition, and as Attraction, in every form, physical and chemical, is a superstitious absurdity, the public mind cannot be too often disabused on the subject. Geometry, the laws of mechanics, and the exercise of patient common sense, would, in like manner, unravel all the chemical attractions, while the developement would be *knowledge*, instead of mystified assertion, and a key to many present difficulties.

ATTWOOD'S MACHINE, is a toy to illustrate the phenomena of acceleration in falling bodies, by which that which is in itself very simple is made very complex. The price is 28*l*. Acceleration arises from surfaces being moved, and surfaces in different times being as the squares of the times in which they are generated by the earth's motions.

AUCTION, is a public sale to the party offering the highest price, where the buyers bid upon each other; or to the bidder who first accepts the terms offered by the vendor, where he sells by reducing his terms until some one accepts them. In England all auctions are much obstructed in fairness by confederacies of brokers and traders, to buy particular articles. This mode of selling is subject to particular regulations, by the laws of many communities, the object of which is to prevent frauds, or to levy a tax. A question was made in the case of Bexwell *v.* Christie (*Cowper's Reports*, p. 395,) whether a sale by auction was fair, at which some one bid for the owner. The subject was treated as being, in some measure, a question of conscience, upon the supposition that the real bidders supposed themselves to be bidding only against other real bidders; and the purchaser at the sale, in that case, was held not to be bound by his bid, because there had been by-bids on behalf of the vendor. But the decision, in that case, was subsequently overruled by Lord Rosslyn, in the case of Conolly *v.* Parsons (3 *Vesey Jr.'s Reports*, p. 625,) and again by the Master of the Rolls, in Bramley *v.* Alt. (3 *Vesey Jr.'s Reports*, p. 620,) with one qualification, however, in this latter case, viz. that if none bid, except by-bidders, or puffers, against one real bidder, to whom the article was knocked down, he was not bound by the purchase. It is evident that the fairness or unfairness of this proceeding must depend, in any case, very much upon a compliance with the understanding entertained, or the conditions laid down in respect to the sale; and, certainly, it is not universally understood that no bidding will be made for the vendor.

AUTOMATON, a self-moving machine. Machines of this kind are kept in motion by means of springs or weights. When they represent human figures, they are called *androides;* but clocks, watches, &c. are also automata. We find very early mention of them. Homer describes Vulcan fabricating tripods, which moved on living wheels, instinct with spirit. The celebrated statue of Memnon, which emitted musical sounds at sun-rise, the walking statues of Dædalus, the flying dove of Archytas, are instances of ancient skill in this respect. In modern times, friar Bacon constructed a brazen head which spoke. Regiomontanus made a flying eagle, and an iron fly, which, after making the tour of the room, returned to its master. Albertus Magnus, in the 13th century, spent 30 years in constructing a human figure, which advanced to the door when any one knocked, opened it, and saluted the visitor. In the water-clock presented by Charlemagne to Haroun al Raschid, 12 doors in the dial opened respectively at the hour which they represented: they continued open till noon, when 12 knights issued out on horseback, paraded round the dial, and then, returning, shut themselves in again. Camus constructed an ingenious toy for Louis XIV. consisting of a carriage drawn by two horses, containing a little figure of a lady, with a coachman and attendants. The coachman smacked his whip; the horses moved their legs naturally, and, when the carriage arrived opposite to the king's seat, it stopped; the page stepped down, and opened the door; the lady alighted, and presented a petition to Louis.

The flute-player, the tambour-player, and the wonderful duck of Vaucanson, are celebrated for the astonishing ingenuity displayed in their construction. The two brothers Droz have executed some admirable works of the kind. One of them is a child, sitting at a desk, who dips his pen into the ink, shakes it, and writes, in French, whatever is dictated to him. This must be done, of course, by human intervention. A vase, presented to Buonaparte, when first consul, on being touched, exhibited a palm-tree, under which a shepherdess was spinning.

The chess-player of Von Kempelen has been supposed to be moved by a man concealed in the chest. The speaking machine of the same artist, the flute-player of Siegmeier, the trumpeters of Maelzel and Kaufmann, deserve mention among the latter automata.

One of the most ingenious automatical mechanists of the present day is that of Maillardet. He constructed a female figure, which performs 18 tunes on the pianoforte; the bosom heaves, the eyes move, and the natural motions of the fingers are performed. The action of this machine continues an hour. Besides this figure, there is a magician, who answers any question taken from 20 medallions. The medallion selected is placed in a drawer, the magical books are gravely consulted, and the magician then strikes with his wand against a door, which opens, and displays an appropriate answer.

His other automata are, a boy, which draws and writes; a little figure, a few inches in height, which dances to music produced in a glass case, in which it is enclosed; a humming-bird, which issues from a box, sings, and returns to the box again; a steel spider, a hissing serpent, &c.

The deception of the invisible girl was managed by a tube and a set of trumpets; and other deceptions are effected by concealed concave mirrors, which reflect sounds to each other's focus, through gauze partitions.

An engine has been made by Mr. Babbage, capable of computing any table by the method of differences. The greater the number of differences, the more it will outstrip the most rapid calculator.

AURUM FULMINANS, a very violent and even dangerous fulminating powder, is made by dissolving a few grains of gold in aqua regia, and adding water of ammonia to precipitate the gold. The least friction, or very slight heat, explodes it.—*See* FULMINATION, DETONATION, &c.

AURUM MUSIVUM, consists of an amalgam of 12 of tin with 3 of mercury, triturated with 7 of sulphur and 3 of sal ammoniac. This compound is then exposed to a gentle sand-heat in a matrass, when, the white fumes abating, the heat is increased, and cinnabar sublimes with muriate of tin. The residuum is the aurum musivum. If the heat is not moderated, it will form mere sulphuret of tin.

AWS, a name often given to the floats or vanes of water-wheels.

AZOTE, or nitrogen. Though incapable of supporting respiration or combustion, its presence seems to be necessary to dilute the oxygen, and thus diminish its activity. Atmospheric air is a mixture of oxygen and azote, in the proportion of 21 to 79 in volume.

The specific gravity of azote is 0·9757, that of air being taken as unity. Its refractive power is 1·03408. The specific heat of azote and the air, taken in equal volumes, is the same; taken by equal weights, that of azote is greater.

Azote is procured by burning phosphorus, in a receiver, over mercury; the phosphorus unites with the oxygen, and the azote is set free: it still contains a small quantity of carbonic acid, which is separated by shaking the gas in a closed bottle, containing lime-water, from which the air has been exhausted. It is also evolved from decaying organized substances, and forms ammonia with their hydrogen when burnt.

It is also procured by burning any body under a close receiver, or by placing a small animal under a close receiver; either absorb or fix the oxygen and leave the nitrogen, which may be purified by washing.

Azote has a feeble affinity for other substances; the number of mineral compounds into which it enters is, therefore, small.

Animal and vegetable substances differ from each other only in this, that the former contain azote, the latter are destitute of it.

Its equivalent number in the atomic theory is 14, and one of its most remarkable compounds is ammonia, formed of 1 nitrogen and 3 hydrogen.

In combination with oxygen it forms vital air, as gas, commonly considered in the proportion of 4 volumes of nitrogen to 1 of oxygen.

Then we have nitrous oxide, 1· n. and 1 oxygen, equivalent 22.

Nitric oxide, 1 n. and 2 oxygen = 30.

Nitrous acid, 1 n. and 4 oxygen = 46.

Nitric acid, 1 n. and 5 oxygen = 54.

Do. liquid, 1 n. 5 ox. and 2 water = 72.

Nitrogen has not been decomposed, though Berzelius, and other chemists, believe that it is a compound. Indeed, Berzelius gives *nitricum* as the name of its base.

Azote is a very important principle, and will be treated much at large under the heads NITROGEN, NITRIC ACID, NITRE, SALTPETRE, POTASS, &c. for it must be regarded as that *alkaline* principle which, in nature, performs so important a part in actions and reactions with the *acidulous* principle or oxygen.

**BABBAGE'S CALCULATING MACHINE.**—Of all the machines which have been constructed in modern times, the calculating-machine is the most extraordinary. Pieces of mechanism for performing particular arithmetical operations have been long ago constructed, but these bear no comparison to the grand design conceived and nearly executed by Mr. Babbage.—Great as the power of mechanism is known to be, yet, that astronomical and navigation tables can be accurately computed by a machine, that it can itself correct the errors it may commit, and that the results of its calculations, when absolutely free from error, can be printed off, without the aid of human hands, or the operation of human intelligence, is most wonderful.

The calculating-machine now constructing under the superintendence of the inventor, consists essentially of 2 parts, a calculating part, and a printing part, both of which are necessary to the fulfilment of Mr. Babbage's views, for the whole advantage would be lost if the computations made by the machine were copied by human hands, to be transferred to types. The greater part of the calculating-machinery is already constructed, and exhibits workmanship of such extraordinary skill and beauty, that nothing approaching to it has been witnessed. In order to execute it, particularly those parts of the apparatus which are dissimilar to any used in ordinary mechanical constructions, tools and machinery of great expense and complexity have been invented and constructed; and in many instances contrivances of singular ingenuity have been resorted to, which cannot fail to prove extensively useful in various branches of the mechanical arts.

In so complex a piece of mechanism, in which interrupted motions are propagated simultaneously along a great variety of trains of mechanism, it might have been supposed that obstructions would arise, or even incompatibilities occur, from the impracticability of foreseeing all the possible combinations of the parts; but this doubt has been entirely removed by the constant employment of a system of mechanical notation, which places distinctly in view, at every instant, the progress of motion through all the parts of this or any other machine, and by writing down in tables the times required for all the movements, it is easy to avoid all risk of two opposite actions ariving at the same instant at any part of the engine.

The practical object of the calculating engine is to compute and print a great variety and extent of astronomical and navigation tables, which could not be done without enormous intellectual and manual labour, and which, even if executed by such labour, could not be calculated with the requisite accuracy.—Besides logarithmic tables, Mr. Babbage's machine will calculate tables of the powers and products of numbers, and all astronomical tables for determining the positions of the sun, moon, and planets; and the same mechanical principles have enabled him to integrate innumerable equations of finite differences,—that is, when the equation of difference is given, he can, by setting an engine, produce at the end of a given time any distant term which may be required, or any succession of terms commencing at a distant point.

Beside the cheapness and celerity with which this machine will perform its work, the absolute accuracy of the printed results deserves especial notice. By peculiar contrivances, any small error produced by accidental dust, or by any slight inaccuracy in one of the wheels, is corrected as soon as it is transmitted to the next, and this is done in such a manner as effectually to prevent any accumulation of small errors from producing an erroneous figure in the result.

Sir David Brewster mentions the effects produced by a small trial, and by which was computed the following table from the formula $x^2 + x + 41$. The figures, as they were calculated by the machine, were not exhibited to the eye as in sliding rules and similar instruments, but were actually presented to the eye on two opposite sides of the machine, the number 383, for example, appearing in figures before the person employed in copying.

*Table calculated by a small trial engine.*

| | | | | |
|---|---|---|---|---|
| 41 | 131 | 383 | 796 | 1373 |
| 43 | 151 | 421 | 853 | 1457 |
| 47 | 173 | 461 | 911 | 1523 |
| 53 | 197 | 583 | 971 | 1601 |
| 61 | 223 | 547 | 1033 | 1681 |
| 71 | 251 | 593 | 1097 | 1763 |
| 83 | 281 | 641 | 1163 | 1847 |
| 97 | 313 | 691 | 1231 | 1933 |
| 113 | 347 | 743 | 1301 | 2021 |

While the machine was occupied in calculating this table, a friend of the inventor undertook to write down the numbers as they appeared. As soon as 4 figures appeared, the machine was at least equal in speed to the writer. At another trial 32 numbers of the same table were calculated in the space of 2 minutes and 30 seconds, and as these contained 82 figures, the engine produced 33 figures every minute, or more than 1 figure in every 2 seconds. On another occasion it produced 44 figures per minute. This rate of computation could be maintained for any length of time.

Mr. Babbage's engine can extract the roots of numbers, and approximate to the roots of equations, and even to their impossible roots. But its object is to embody in machinery the *method of differences*, and the effects which it is capable of producing, and the works which in the course of a few years we may expect to see it execute, will place it at an infinite distance from all other efforts of mechanical genius.

BACON, is the sides of killed hogs, soaked in brine, and then dried in a smoky situation. In general, it is very difficult of digestion.

BAGPIPE, a favourite Scotch instrument, played by wind in a bag, pressed with varied force into bass and treble pipes, called the *drone*, of one drill tone, and the chanter. The Highland instrument has two drones. The Irish one has two short drones, and a long one is an improvement.

BAKEHOUSE. This usually consists of a dresser, a kneading-trough seven feet long, three deep, and two and a half wide at top, narrowing to the bottom. A copper and fire-place. An oven of brick, with a stone floor, and sometimes a flue from a fire-place, winding round it, but more commonly the oven is heated with faggots, burnt within it. It is raised to 450°, tested by flour thrown in and turning black on the floor without inflaming.

The flour is sifted in the kneading-trough, to make it light and remove dirt. An ounce of alum and $4\frac{1}{2}$ lbs. of salt are then dissolved in a pail of hot water, in a tub, to which, at 84°, three pints of yeast are mixed. This is then poured into the flour, and mixed up as stiff batter, covered up, and called *setting sponge*. In three hours the fermentation is complete; more water and flour is added, and *half sponge* is set for five hours. Three other pailfuls of water are then added. The whole is then united and kneaded for an hour and set again for four hours. Another kneading for half an hour prepares the dough for loaves and for the oven, where they are close-stopt for two and a half hours. Hence, a baking employs from 13 to 15 hours of the 24, and must be regarded as a severe employment, and that, in general, through the night. Alum is said not to be used by all bakers, but loaves will not separate without it; it improves the colour, and when not used in greater quantities than an ounce in 347 lbs. of bread, cannot do injury.

A machine has been made for kneading dough, similar, in general mode of acting, to that used for grinding clay.

BALANCES, or Scales, are levers suspended in the middle, to each end of the equal arms of which are appended scales, one for known and agreed weights, and the other for the article to be weighed. They are subject to friction, to wear, and to irregularities, of which many dealers take advantage. There are juries to examine them, but as visits are anticipated, detections of frauds are not numerous. Some delicate balances determine a weight within the 1000th of a grain, and others to the 30 or 50,000th of the weight.

*Weights* run from the hundredth of a grain up to hundred weights. The smallest should always be platina, since they do not vary or rust. Brass is the next best metal. Iron and lead the worst. They are best examined by making up the same amount in different weights, and then trying their balance.

| | | |
|---|---|---|
| An ounce, oz. avoirdupois | | 437·5 gr. |
| A pound, lb. | .. | .. 7000 |
| A troy oz. | .. | .. 4800 |
| A troy lb. | .. | .. 5760 |
| A French gramme | | .. 15·4063 |

The French litre is 61·02525 or 15406·3 grains.

A decigramme 1-10th, a centigramme 1-100th, and a millegramme 1-1000th.

A hundred-weight is 112 lbs.

A ton, 2240 lbs.

1000 ounces, or 437,500 grains, of water, are a cubic foot. A pint is 8750 grs. or 34·659 cubic inches.

A cubic inch of water, at 62°, is 252·458 grs. An imperial gallon is 277·274 cubic inches, or 70000 grains of distilled water, or 10 lbs. avoirdupois.

Fine weights are made by weighing a length of fine wire, and then cutting it into equal or unequal parts, the weights of each being as the length. If a yard, 36 inches, of wire weighs half an ounce which is $\frac{7000}{32} = 218\frac{3}{4}$ grains, then half an inch is 3 grains nearly, an inch 6 grains, and the 6th 1 grain. Other wire may be but a quarter of an ounce, and the divisions may be carried to the 16th.

Balances are made which turn with the 70th of a grain, *i. e.* nearly the half millionth of a lb.

BALCONIES, are elegant and convenient appurtenances to modern houses, supported by trusses of wood or iron, and surrounded by a well-fixed railing, with uprights and a veranda. They are often very ornamental, and the verandas are of painted sheet-iron or oiled-cloth.

BALDNESS, an incurable result of advanced age; but, in temporary cases, may be relieved by washing the part with a mixture of equal parts of juice of burdock-root, honey, and spirits. The vulgar nostrum of bears' grease is a disgrace to the intelligence of the age.

BALL AND SOCKET, is a contrivance for precise motion in any direction, effected by the elasticity of a piece of cork placed at the bottom of the socket, and tightened by a screw.

BALLAST, is the heavy material put into the vacant spaces of an empty ship, to give her sufficient purchase in the water. It generally consists of old iron or shingle. First-rate men-of-war, of from 2100 to 2200 tons, carry 550 tons of ballast. 50-gun ships of 1100 tons, 235 tons; and 24-gun frigates of 500 tons, 130 tons; and 20-gun of 400 tons, 110 tons: about one-fourth of the tonnage. It is stowed from head to stern, and the shingle upon the iron.

BALLOON, is a volume of light gas, enclosed in a silken sphere, coated with gum, or dissolved caoutchouc, as absolutely air and water-tight. It is founded on the principle of the orbit motions of gaseous atoms, some of which are smaller or rarer but revolve in a larger space, and though the volume has less weight, yet their greater velocity in their orbit enables them to react against the atmospheric pressure, and maintain their own space. This pressure of one and reaction of the other constitutes their elasticity. Common air itself becomes lighter if put into more motion, or excited by the motion of heat; hence the first balloons were of mere rarefied air, or smoke, three times rarer than common air. But Priestley's discovery of oxygen, hydrogen, and the separate gases, (of which hydrogen, in particular, is above 14 times lighter than air, and with equal internal force or elasticity) enabled philosophers to apply hydrogen to purposes of aerostation about 1783.

A balloon is filled by making the gas, and passing it through water into the balloon. The means are, to put zinc, or iron-filings, into casks, and pour on it 1 sulphuric acid with 5 water, and an extrication of hydrogen gas, or decomposition of the water, is the consequence. Zinc gas is 12 to 1 of air; iron-filings gas little above 6 to 1 of air.

Balloons have been useful for certain philosophical determinations; but, until some means of guiding them is ascertained, they are to be considered only as interesting toys.

To determine the ascending powers of a balloon, we have to determine the difference between the weight of its volume of air and the weight of the volume of gas with which it is filled.

To determine the volume, we have to cube the diameter in feet, and multiply by 0·5236; or to cube the circumference, and multiply by 0·0168; or to multiply the circumference by the diameter, and divide by 6.

Then a cubic foot of *air*, bar. 30° ther. 60°, weighs 523·368 grains; and a cubic foot of hydrogen gas weighs 36·6 grains. Then the ascending power of hydrogen is as 14·41 to 1, such being the exact ratio of their weights per foot.

But as hydrogen is made for this purpose, and is never pure, we ought not to take the ratio higher than 10 to 1. The ordinary carburetted hydrogen, made from coals or at gas-works, weighs 512·36 grs. to the cubic foot; and, consequently, gives a power of ascension of only 529 — 512, or only 27 grs. to the cubic foot; whereas, pure hydrogen gives 523 — 36·6 = 487·4 grs. as its power per cubic foot.

As an example, a balloon of 30 feet diameter has a content of $30 \times 30 \times 30 =$ 27,000 feet, which, by ·5236, gives 14,137 cubic feet. Then, this of air, at 523 grs. to the foot, would weigh 7478573 grs., which, at 7000 grs. to the pound, would be 1056 lbs. Taking hydrogen, then, of zinc and sulphuric acid, as 1 to 10, the ascending power would be $1056 - \frac{1056}{10}$ = 950 lbs.; or, if of iron-filings and sulphuric acid, whose ratio is but 1 to 6, $1056 - \frac{1056}{6} = 880$ lbs. Of course carburetted hydrogen, as 512 to 523, would give but $11 \times 27{,}000$ grs. or 42 lbs.

When gas companies fill balloons they prepare gas as 3 or 4 to 1, and with this power Green, Sadler, &c. have made many aerial voyages in balloons of 36 or 40 ft. diameter.

From this 950 lbs. and 880 lbs. are, however, to be deducted the weight of the material of which the balloon is made, the car, netting, ropes, &c. The material is the number of square yards in the surface of the balloon, and this is equal to the product of the diameter, by the circumference in yards; or the square the diameter by 3·1416; or to square of the circumference by 0·3183. Thus, in a balloon of 30 feet, or 10 yards, the square of 10 is 100, and this, by 3·1416, is 314·16 square yards of silk, the weight of which may be determined by weighing a yard. In cutting out a balloon 30 feet diameter, it is computed to consume about 450 yards, yard-wide.

A trial balloon of five feet in diameter, containing $62\frac{1}{2}$ cubic feet, and its weight known, is usually on the spot, to determine the rarity of the gas with which the balloon is filling.

In determining the contents or surface, if the balloon is not a true sphere, add the longest and shortest diameters together, and use the half in computing.

If it is required to make a balloon of 30 feet diameter, the circumference will be $30 \times 3{\cdot}1416$ or $94\frac{1}{4}$ feet. Then, if the silk is one yard, or 36 inches wide, it will require $31\frac{1}{3}$ clear breadths at the equator, and dividing the distance from the equator to the poles into four parts, the gores, at one-fourth from the equator, must be

$31\frac{3}{8}$ inches; at one-half from the equator, $25\frac{1}{2}$; and, at three-fourths, or one-fourth from the pole, $12\frac{1}{3}$ inches; and, as a check on the measures, observe that at two-thirds from the equator, it is exactly half a yard; and at seven-tenths from the equator it is exactly 12 inches. Thus any one may cut out a spherical balloon.

BALM OF GILEAD, is the dried juice of a low tree or shrub (*amyris gileadensis*,) is obtained by boiling the twigs and leaves in water. It is thin and oily, or, by a longer continued decoction, is thicker and less odoriferous. It is antiseptic and vulnerary. It is used also as a cosmetic. By the inhabitants of Syria and Egypt, this balsam was in great esteem from the highest periods of antiquity. It was then, and is still, considered one of the most valuable medicines that the inhabitants of those countries possess. The bark of the trees is cut with an axe, at a time when its juices are in their strongest circulation. These, as they ooze through the wound, are received into small earthen bottles; and every day's produce is gathered, and poured into a larger bottle, which is closely corked. When the juice first issues from the wound, it is of a light yellow colour, and a somewhat turbid appearance; but, as it settles, it becomes clear, has the colour of honey, and appears more fixed and heavy than at first. Its smell, when fresh, is exquisitely fragrant, strongly pungent, not much unlike that of volatile salts; but if the bottle be left uncorked, it soon loses this quality. Its taste is bitter, acrid, aromatic, and astringent. The quantity of balsam yielded by one tree never exceeds sixty drops in a day. Hence its scarcity is such, that the genuine balsam is seldom exported. Even at Constantinople, the centre of trade of those countries, it cannot, without great difficulty, be procured. In Turkey, it is in high esteem as an odoriferous unguent and cosmetic. But its stimulating properties upon the skin are such, that the face of a person unaccustomed to use it becomes red and swollen after its application, and continues so for some days.

BALSAM, is a term formerly applied to any strong-scented vegetable resin, of about the fluidity of treacle, inflammable, not miscible with water without addition, and supposed to be possessed of many medical virtues. All the turpentines, the Peruvian balsam, copaiba, &c. are examples of natural balsams. Many medicines, also, compounded of various resins or oils, have obtained the name of balsams. Lately, the term has been restricted to those resins which contain benzoic acid. The most important balsams are those of Tolu and Peru —*storax* and *benzoin*, as they are named: the latter is concrete, the former fluid, though it becomes solid with age. They are odorous and pungent, and useful only as articles of the materia medica. The benzoic acid is extracted from them either by applying a gentle heat, when it is volatilized, or by maceration in water, when it is dissolved. The *Copaiva* balsam is from the copaifera-tree of South America. The *Peruvian* from the Myroxylon. The *Mecca*, or *Gilead*, similar to the *Canada*, from the pinus balsamea. The *Tolu*, like the Peruvian. The *Storax*, from the styrax officinale, from Asia Minor. The *Benzoin*, or benjamin, from Sumatra, and the Frankincense, or Olibanum, of the Ancients, sold of three distinct qualities. It is the incense of the gods, the purifier of bad air, and the accompaniment of tobacco, in many nations. *Dragon's Blood* is another, from the Sumatra rattan, called calamus draco.

*Balsamum Judaicum*, *Opobalsamum*, exudes from incisions made in amyris gileadensis, or amyris opobalsamum, and is at first turbid, yellow, becomes clear, gold colour, of a very penetrating sweet turpentine smell, and has a sharp, bitter, astringent taste: a drop of it let fall on warm water spreads over the whole surface, and on the water cooling, again contracts itself.

*Balsam of Honey*, (Tincture of Benjamin.) In one lb. of alcohol digest two ounces of Benjamin. Or, in eight ounces of alcohol digest one ounce each of benjamin, storax, and calamus. Or, the latter, with double quantity, half a dram of essence of jasmine, half a scruple of oil of rhodium, and four grains of musk and of civet. It is used to perfume clothes, ventilate sick-rooms, or mix with rose-water, to form milk of roses.

*Hill's Balsam of Honey.*—Four pints of alcohol, and half a pound each of honey and balsam of tolu. Or, two pints of alcohol, eight ounces of honey, half an ounce of opium, two drachms of gum storax, and 2 ounces of balsam of tolu.

*Balsam of Life.*—In sixteen ounces of water boiled to twelve, half an ounce of extract of liquorice, two scruples of subcarbonate of potass, and one drachm each of myrrh, crocus, and succotrine aloes; strain, and add four ounces of compound tincture of cardamoms. Improves by age. The dose half an ounce to two ounces. Stomachic and aperient.

*Canada Balsam*, from pinus balsamæ, is used for balm of Gilead.

*Balsam of Capiri*, flows from the copaifera officinalis; detersive, vulnerary, diuretic, and astringent.

*Hungarian Balsam*, exudes from the extremities of the branches of pinus pumilio, and is also obtained by expression from the cones.

*White Balsam of Peru*, is obtained by incision from myrospermum Peruifera.

*Red Balsam of Peru*, or *Balsam of Tolu*.—Colour reddish, agreeable sweetish taste, a middle consistence between liquid and solid, very glutinous, the fragrancy of lemons.

*Black Balsam of Peru*, or *Common Balsam of Peru*, is obtained by boiling the bark and branches in water. The balsams of Peru all contain benzoic acid, which gives them a very fragrant smell.

BAMBOO CANE, has a hollow, round, straight, and shining stem, and grows to the height of forty feet and upwards. It has knots at the distance of ten or twelve inches from each other, with thick, rough, and hairy sheaths, alternate branches, and small, entire, and spear-shaped leaves. There is scarcely any plant so common in hot climates, and few are more extensively useful. It occurs within the tropical regions, both of the eastern and western hemispheres. In temperate climates, it can only be cultivated in a hot-house; and its growth is so rapid, even there, that a strong shoot has been known to spring from the ground and attain the height of twenty feet in six weeks. They grow in shoots, cut every two years, when they are 50 or 80 feet high.

The inhabitants of many parts of India build their houses almost wholly of bamboo, and make all sorts of furniture with it. They likewise form with it several utensils for the kitchen and tables.

From two pieces of bamboo, rubbed hard together, they produce fire. The masts of boats, boxes, baskets, and innumerable other articles, are made of bamboo. After having been bruised, steeped in water, and formed into a pulp, paper is manufactured from the sheaths and leaves. The stems are frequently bored, and used as pipes for conveying water; and the strongest serve to make the sticks or poles with which the slaves or servants carry those litters, so common in the East, called *palanquins*. The stems of the bamboo serve as the usual fence for gardens and other enclosures; and the leaves are generally put round the tea exported from China to Europe and America. Some of the Malays preserve the small and tender shoots in vinegar and pepper, to be eaten with their food. Walking-canes are formed of young bamboo shoots.

The Chinese make a kind of framework of it, by which they are enabled to float in water; and the Chinese merchants, when going on a voyage, always provide themselves with this apparatus to save their lives in case of shipwreck. It is formed by placing four bamboos horizontally across each other, so as to leave a square place in the middle for the body, and, when used, is slipped over the head, and secured by being tied to the waist.

BANANA, is a valuable plant (*musa sapientium*) which grows in the West Indies and other tropical countries, and has leaves about six feet in length and a foot broad in the middle, and fruit four or five inches long, and about the shape of the cucumber. When ripe, the banana is a very agreeable fruit, with a soft and luscious pulp, and is frequently introduced in desserts in the West Indies, but never eaten green, like the plantain. The banana is sometimes fried in slices as fritters. If the pulp of this fruit be squeezed through a fine sieve, it may be formed into small loaves, which, after having been properly dried, may be kept for a great length of time. It may be fruited in England, in a stove large enough.

BANDANAS, are silk handkerchiefs made equal to India, at Macclesfield and Manchester.

BANKS, are establishments for dealing in money, and circulating securities, and as such are general through Europe under the name of *negocians*. But in England, after the plan of the Government Bank, they became, about 1760, BANKS OF DEPOSIT, for receiving the spare money of a neighbourhood, with or without interest. On this plan they became powerful means of supporting trade, industry, and improvements, and by simultaneously increasing their capital by issuing small notes, they produced the wonderful social prosperity of the United Kingdom from 1785 down to December 10, 1825. On that day, and for several days after, a general panic seized on the nation to realize at once all the circulating paper in gold, and in consequence nearly 200 banks stopt payment and were ruined, while others were rendered inefficient. The bank of England lent no aid till too late, and when *departed* credit, more than departed life, could not be restored. In consequence, thousands of mercantile and manufacturing establishments, dependant on the general credit, were suddenly ruined. The government, utterly ignorant of the nature of the banking system, and of the real source of public wealth in mutual credit, instead of taking means to palliate the blow, adopted laws to confirm it, and render it more perfect in its disastrous effects. In consequence, from that time down to the spring of 1833, trade and enterprize have been but a tottering remnant of reckless adventure, and manufacturing has, in general, been carried on either without profit, or at a loss to all concerned. The proud ascendancy of England thus succombed before official and too-well paid ignorance or theoretical obduracy, and it is now said to be too late to attempt a restoration, though 60 millions per annum are still assessed on the people. Banks of Deposits were creations of long time, and well-earned confidence, and each of them was to the state worth a million.

800 or 900 banks, spread over the United Kingdom, and consisting for the most part of a company of men of known property, tended in a surprising manner to augment the floating capital or credit in activity, between 1790 and 1825. The scattered credit of each was 1 or 200,000*l.* and was employed in various ways as matter of business to the extent of 100,000*l.* on the average, forming 80 or 90 millions of capital, constantly directed to agriculture, manufactures, and various industry. But, in 1826, an ignorant ministry and legislature so impaired these local centres of credit as to reduce them to an average of a third or fourth; while the sudden reduction of so large a mass of active capital, from 80 or 90 to 20 or 30 millions, with the moral effect and the difference in working, not only paralyzed the public industry, but destroyed the other capitals of credit of many thousand establishments and trading concerns, whose several credits and transactions generated and made up the whole capital of the empire.

The credit and capital of country bankers, loaned in their vicinity, was *the capital of industry;* and they served as numberless springs to restore the *constant stream* in taxes to the seat of government, and in rents to the chief residence of landlords in the metropolis.

The use of currency, as means of fructifying industry, does NOT depend on its total amount, since it may be, as it is, accumulated by few hands in one locality; but on its creation where it is wanted, and then sustained by a circulation through dealers in money, who alone can give to avaricious accumulators the security which they exact.

It was the system of this effective circulation which enabled the people of England to pay 70 millions of taxes in 1810 with greater ease than 5 millions in 1710. The monetary system and the amount of taxes were identical, and the attempt to detach and collect the taxes, without the means in the system, lead to the flight of all enterprise and the emigration of all prudent persons.

The *elite* of British industry were basely and ignorantly robbed of several hundred millions, in 1826, by enactments which operated *suddenly;* but the restoration of the system would have no sudden effect, depending on credit, prudence, &c. and likely to operate only in a course of years. It is a question which involves the power of paying the 70 millions of assessments or of public bankruptcy.

SAVINGS' BANKS were instituted for the purpose of collecting the money of the labouring classes for public objects, and allowing them interest, without charge of management, but by a late law the interest was reduced to 3*l.* 8*s.* 5½*d.* per cent., and the amount has been sunk in the public debt; government being answerable to the contributors in full. The deposits average about 4*l.* per family in the United Kingdom, or are nearly 14 millions. There are 487 of these concerns, and about 400,000 accounts.

BARBADOS NUT TREE, (*jatropha curcas.*) The seeds are the common physic nut, violently purgative and emetic; when carefully peeled they yield oil, and shrub, on incision, a lactescent and caustic juice which dyes linen black. The leaves are rubefacient.

BARBERRIES, are a beautiful red and oblong-shaped fruit, produced in small bunches by a shrub (*berberris vulgaris,*) with somewhat oval, serrated and pointed leaves; thorns, three together, upon the branches, and hanging clusters of yellow flowers. When boiled with sugar, it makes an agreeable preserve, rob or jelly, according to the different modes of preparing it. Barberries are also used as a dry sweetmeat, and in sugar-plums or comfits; are pickled with vinegar, and are used for the garnishing of dishes. They are well calculated to allay heat and thirst in persons afflicted with fevers. The bark of the barberry shrub is said to have been administered with effect in cases of jaundice, and in some other complaints; and the inner bark, with the assistance of alum, dyes linen a fine yellow color. The roots, particularly their bark, are employed, in Poland, in the dyeing of leather. A very singular circumstance has been stated respecting the barberry shrub, that grain, sown near it, proves abortive, the ears being, in general, destitute of grain, and that this influence is sometimes extended to a distance of three or four hundred yards across a field.

BARCLAY'S ANTIBILIOUS PILLS, consist of 2 drachms of colocynth, 2 of extract of jalap, 1 of almond soap, 3 of guaiacum, 8 grains of tartarized antimony, 1 of oils of juniper, carraway, and rosemary, and 4 of syrup of buckthorn, divided into 64 pills.

BARGES, are of various kinds, and in the Thames acquire various names, according to the variety of their uses and structure: as,

A company's barge, a row barge, a royal barge, a sand barge, a Severn trow, a canal barge, a ware barge, a light horseman, a west-country barge.

A barge differs from a bark, as being smaller, and used only on rivers. There are also barges belonging to men-of-war, serving to carry admirals and commanders. Sailing-barges are vessels with one mast, and sometimes a bowsprit. Those that have boom-sails, are rigged like sloops; but, having few hands on board, the boom and gaff are more easily hoisted or topped, the power being increased by the addition of blocks. Sailing lighters or barges, with a sprit-main-sail, rig with a sprit-yard at the head of the sail, hanging diagonally to the mast. Some large barges have a ship's mizen, and a down hauler at the peek-end of the sprit-yard. Large barges have a fore-sail, jib, cross-jack-yard, and top-sail, similar to sloops.

BARILLA, a product obtained from the combustion of certain marine vegetables. This word is the Spanish name of a plant (*salsola soda*,) the ashes of which afford the alkali (soda.) It is also procured from the ashes of prickly saltwort, shrubby saltwort (*salsola fruticosa*) and numerous plants of other tribes. The plants made use of for burning differ in different countries; and the residue of their incineration contains the soda in various states of purity. The plants of Spain and Africa contain from 25 to 40 per cent. of carbonate of soda; whereas that from the *salsola* and the *salicornia* of other districts affords but half. The variety known under the name of *kelp*, procured by burning various sea-weeds, is a still coarser article, not yielding above 2 or 3 per cent. of real soda.

Barilla, or carbonate of soda, is found native in immense quantities in some countries. The Trona Lake, in Egypt, furnishes 80 to 100 tons annually. Kelp from sea-wrack is its worst description, but the Orkneys supply 3,000 tons. The best is made near Alicant and at Ustica, in Sicily. 500 parts of the *Salsola Soda* afford 100 ashes; and 500 ashes 113 salt, 68 subcarbonate of soda, and 204 subcarbonate of magnesia, 100 sand and iron, and 23 water.

The French make carbonate of soda from sea-salt, by mixing 2 salt, 6 litharge and 1 chalk, and agitating them. The soda crystallizes. In England 5 sulphate of soda, 1 charcoal, exposed to great heat and lixiviated, yields crystals of soda.

*British Barilla*, is made from the ashes of *salicornia Europæa*, calcined into a porous mass. 2 per cent. of subcarbonate of soda.

*Kelp Barilla*, is the ashes of the *fucus vesiculosus*, and several other species. 3 per cent. of subcarbonate of soda.

*Smyrna Barilla*, is the ashes of the Mesembryanthemum Copticum and Salsola kali. It contains about 40 per cent. of subcarbonate of soda.

*Barilla Ashes*, or Spanish barilla, is made from Mesembryanthemum nodiflorum, burned with salsola sativa. It contains about 25 per cent. of subcarbonate of soda.

*East India and Cape Barilla*, is made from Salsola Indica. S. Aphylla, S. nudiflora, and S. elata; and has 45 per cent. of subcarbonate of soda.

*Blanquette Barilla*, is the ashes of salicornia Europæa, Salsola tragus, Atriplex portulacoides, Salsola kali, and Statice limonium, and contains about 8 per cent. of subcarbonate of soda.

There are several other kinds.

The native kind is found as a mineral in Egypt, Hungary, &c. It is an article of extensive use in glass-making, soap-making, bleaching, &c. &c. It is a solid, soluble in water, of a hot, acrid, bitter taste. It changes the blue colour of vegetables to green; a property which belongs to a class of bodies denominated alkalies. Between these two bodies a strong affinity subsists. If into a solution of the latter we carefully drop a portion of the former, a brisk effervescence will ensue, and carbonic acid, or fixed air, will be given off, as from soda water. If the experiment be performed with care, and the dropping in of the acid stopped, the moment the effervescence ceases, the solution will be found to be warm, and to be possessed of properties totally different from those of the acid and the alkali from which it has been formed. It will not be sour, corrosive, acrid, nor hot. It will have no action upon blue vegetable colours, and all the active properties of the original bodies are said to be *neutralized*—they have *neutralized* one another. The product is slightly bitter, saline, and cooling. If part of the water be driven off by heat (or evaporated,) a solid will be deposited in regular forms, which was previously held in solution by the water which escapes. This substance is known by the name of Glauber's salt, or sulphate of soda, and is extensively used in medicine.

Barilla or carbonate of soda is capable of acting strongly upon pounded flint, and produces, by its combination with it, the well-known substance crown glass: but before the cohesion in the flint is diminished by pounding, the chemical action between them is not efficient.

It is a question, whence comes the alkali of burnt wood and vegetables generally? We are taught that nitrogen is indifferent in combustion; but though we find oxygen in burnt metals, we find nitrogen or alkali in burnt wood, &c. Either alkali or nitrogen is a constituent of all vegetation which many alledge; or in the burning, while the hydrogen fixes oxygen, the carbon and smoke fixes nitrogen, and generates the alkali. Since plants which yield potash yield soda, with salt manure, it is conceived that the alkali is a constituent, but the salt manure may merely vary the combining nitrogen.

BARIUM, is an alkaline metal, of which the balanced alkali is the oxide, Barytes, a decomposition of the carbonate or sulphate. Exposed to the poles of a galvanic battery, the oxygen of the oxide barytes is driven off, and barium formed. It is the strongest of the alkaline bases, and strontian next.

The hydratic peroxide of barium, employed to prepare peroxide of hydrogen, may be obtained with the greatest facility by the following process. Heat caustic barytes in a platinum crucible, by means of a spirit-lamp, until it is nearly red-hot, and then throw in, by small quantities at a time, chlorate of potash; incandescence takes place, and the protoxide becomes peroxide of barium. When the mass is cold, dissolve the chloride of potassium by solution in cold water; the peroxide becomes a hydrate during this operation, and remains in the state of a white powder. It may be dried by exposure to the air, without heat. It appears to contain six bulks of water.

BARK, Peruvian, is the produce of a tree of the species of *cinchona*, which is the spontaneous growth of many parts of South America, but more particularly of Peru. The tree is said somewhat to resemble a cherry-tree in appearance, and bears clusters of red flowers. The tree grows abundantly in the forests of Quito and Peru, and the bark is cut by the natives in the months of September, October, and November.

The bark is of three kinds—the red, the yellow, and the pale. The first has now become scarce, the yellow and pale barks having been found to be stronger in their febrifuge properties. The *crown-bark*, as the highest-priced is termed, is of a pale yellowish-red.

Its medicinal properties were found, a few years since, to depend upon the presence of a substance called *quinine*. This exists, more or less, in all kinds of Peruvian bark, but in quantities very unequal in the various kinds. The most useful and permanent form of the substance is that of a neutral salt, in which it is combined with sulphuric acid, constituting *sulphate of quinine*. This extract is so powerful, that one grain of it is a dose.—*See* Quinine.

Bark, the outer coat of oak or larch trees in England, is an important article in tanning leather. Besides the native production, large quantities of oak bark are imported as an astringent in tanning.

*Quercitron*, is another bark used for yellow dyes.

*Autor Bark*, resembles coarse cassia, and is used in making fine carmine.

*Pale Bark*, mixed with nitric acid, raises the thermometer 49 deg. Yellow bark 52° and red bark 48°. Nitrous fumes indicate the decomposition of an acid. They contain 3-4ths carbon, and the other fourth is nitrogen, hydrogen, and oxygen.—*A. T. Thomson.*

Bark and seed is commonly crushed by 2 vertical stone wheels, rolling on an axis, which turns on an axis, and pass over the material to be pulverized.

Barks dried for medical purposes generally require the outer part to be taken off, as inefficient.

The chemical properties of barks differ much, but cannot be examined in Europe. The infusion of some kinds precipitates both isinglass jelly, and the infusion of nut-galls; others, only one or other of these, but the chemists are deceived by the mixture of several species of barks. Medically, all are tonic and febrifuge, and, for intermittent fevers, may be given in powder an ounce between each fit, in doses from 1 scruple to 3 drachms every 2 or 4 hours. They are also used to stop gangrene, and are given in infusion and decoction.

BARK MILLS, are assemblages of machinery for chopping, grinding, and preparing bark for tanners, and sometimes they embrace some of the tanner's business. The bark is cut or chopped by a lever, armed with knives at the top of the building, and falling through a grating to the hopper, passes through stones in the usual manner.

BARKER's MILL, is a very ingenious production of power, by the reaction of a heighth of water from 2 ends of an horizontal tube with lateral orifices, by which a spindle is turned with sufficient force to turn stones and grind corn. Its simplicity recommends it to general use, even in manufactories on a small scale. Gregory states, that it has been improved by Rumsey and Segner.

BARLEY, a common grain used as bread, and more generally as malt for making beer, for which purpose it is dried in kilns and bruised. When stripped of its husk it constitutes the delicate article called pearl barley.

Of barleys there are,—spring barley, Turkey barley, square barley, bere, naked barley, black barley, barley wheat, full barley, six-sided barley, bigg, round barley, winter barley, Greek barley, sprat barley, battledore barley, and German rice. All these are cultivated for making bread, pearl barley, malt, or spirit.

Barley suits sandy and light soils, and is a succession crop on the rotation system. In Britain it is less used for food than for malting and for distillation, in which it is an important staple. 1,000 parts of barley contain 115 volatile matter, 190 husk, and 695 meal. 1,000 parts of meal by itself yield 95 volatile matter, 12 albumen, 54 saccharine matter, 45 mucilage, 35 gluten, 70 husk, $2\frac{1}{4}$ phosphate of lime, and the remainder starch. The peculiar flavour which it gives to spirits arises from an acrid essential oil, which floats at top when barley meal is macerated in spirits of wine, and which is the volatile matter above mentioned.

*Pearl Barley* is the seed of spring barley, steamed to soften the skin, then dried, and ground in a mill to separate the husk, except that lodged in the deep furrow of the seed. In *Scotch pearl barley* the seeds are ground smaller than the last into spherical granules, generally made from bigg or bere. All these pearl barleys make a cooling gruel, thicken soups, and are ingredients in pectoral and anti-febrile drinks.

But by far the best way of using it is by pounding it in a mortar. In this form it rivals tapioca, or ground rice, and can be easily procured at one-twelfth of the price of the first, and one-third of the price of the last.

English barley yields one-fifth more fermentable matter than Scotch.

Barley loses one-fifth of its weight in malting.—*See* Grain, Seed, &c.

BARLEY SUGAR, is sugar candied by heat and flavoured with lemon-peel.

BAROMETER; an exhausted tube with one end in a basin of mercury, which rises into the tube from 28 to 31 inches, by the active pressure of the atmosphere to get to the exhausted part. This action was formerly ascribed to *suction*, just as the weight of bodies continues to be ascribed to *attraction*. The bore is from a quarter to half an inch. It is filled by pouring mercury into the tube through a funnel, and then inverting several times, so as to raise any air bubbles to the open end. This end is then filled even, and the finger being held on it, it is placed in a small vessel of mercury, the pressure on which sustains that in the tube. A scale of inches and parts should then be annexed. The friction of the glass at the sides being greater than that of the mercury, the fluid always rises and falls at first in the middle. There are various forms, but the principle is always the same, and the variations merely shew the varied elastic pressure of the air.

Pascal requested Perrier, at Clermont, in Auvergne, to make a trial of the pressure of the air on the mountain Puy-de-Dome. Perrier found that the quicksilver in the Torricellian tube, upon the summit of this mountain, 5000 feet high, stood more than three Parisian inches lower than at the foot of the mountain; and thus demonstrated that it was the pressure of the column of air (the height and the weight of which were less on the mountain), that supported the column of mercury in the tube. The gradual fall of the mercury, in ascending the mountain, was also observed. Since the fall of the mercury is in a certain proportion to the height ascended, the barometer is used for the measurement of heights. De Luc found the siphon barometer, which takes its name from its shape, the most useful in making such measurements. In this barometer, the columns of mercury, in both legs of the tube, are of an equal diameter; a scale is also marked on both legs.

That a barometer may be accurate, it is necessary, 1st, that the exterior air only should operate upon it; for which purpose the air must be entirely expelled from the tube; for, if any air is admitted, the column of mercury will not ascend to its proper elevation. In the manufacture of the barometer, the mercury is boiled in the tube to expel all the air.

2d. The scale must be accurate.

3d. The barometer should hang perfectly perpendicular. In observing the barometer, the eye must be kept in an exact level with the upper surface of the mercury, which must be measured at the highest point of its convexity.

Daniel has lately constructed a water barometer, 35 feet high, of surprising sensibility to atmospheric changes.

Mercury is purified for barometers, by digestion with sulphuric acid.

When the barometer is 30 inches at the level of the sea, it is at 1000 feet of elevation, but 28·91; at 2000 feet, but 27·86; at 3000, but 26·85; at 5000, but 24·93; at 10,000, but 17·82; and at 20,000, but 13·85. This increases evaporation, varies the boiling point of water, the ascent of volatile fluids in distillation, &c. &c. The weight of the air is considered as the cause of its elasticity, and therefore the two are equal. No practical use has hitherto been made at Quito, &c. &c. of the diminished pressure, but it is probable that ere long we may hear of manufactories with a view to the increase of evaporation.

The simplest and sufficient rule for determining the heighth of elevations by the *barometer* is the ratio: as the *sum* of the mercurial columns at the foot and the elevation is to their *difference*, so is 52,000 feet to the heighth nearly. This is accurate up to 5000 feet.

Above that heighth the result may be increased by taking the 1000ths of the heighth, halving them, cubing the half, and adding that cube as feet to the first result.

If it is 30 at bottom and 20 at top, as

50 is 10, so is 52,000 to 10,400. Then the 1000ths are 10, half is 5, and the cube of 5 is 125, so that the true heighth is 10,525.

If the heighth is given to determine the fall, 52,000 divided by the heighth gives the sum; and, take from this the rise at the base for that at the top.

The construction of barometers is various, but the principle is the same. The wheel barometer has but half the length of the mercury, acting on the principle of a syphon; and a small float connected with the axle by a thread, turns it, so that an enlarged index points to every variation. The *diagonal* barometer lengths the line of ascent, and enlarges the index. Blondeau's is a steady barometer for use on ship-board. There is also the mountain barometer, adapted for conveyance and rough usage. Lastly, Gay Lussac's walking-stick, or mountain barometer.

Volumes of air are directly as the heighth or pressure of the barometer.

At different temperatures the varying volume is found by multiplying the given bulk in cubic inches, by the difference of temperature and dividing by 480. Then add to or subtract the quotient from the given bulk, as the given temperature is less or more.

If spirits of wine be placed in a bulb at the end of a glass tube, or in a bottle with a long neck, and heat be applied so as to evaporate the spirits, and expel the air from the tube or neck, and the tube or neck be then moved in cold water, the vapour will condense, the tube or neck, the bulb and bottle will become a vacuum, and the water will rise and fill it by the pressure of the atmosphere.

BARREL, is a vessel made of curved oak staves, connected by hoops of iron, or ash, fixed by the curvature and prepared by the trade of a cooper. A barrel is 36 gallons, and other casks are multiples or parts of 36. Thus a hogshead is $1\frac{1}{2}$ barrel, a puncheon 2 barrels, a butt 3 barrels, a firkin a quarter of a barrel, and a kilderkin half a barrel.

When casks stink, hot lime and water, or charcoal and water, often cures them; but brewers usually take out the head, and place them over a fire, so as to char the inside, and then soak them in boiling liquor.

BARTER, the interchange of commodities, before the invention of money, or tokens of value. It was a mode of traffic that prevented accumulation and monopoly, which money facilitates, and hence more than half the ills of social life. But, it is only one step from nature, and modern society has advanced too many to return to a system of mere barter.

BARYTES, one of the earths, so called on account of the great weight of its acid combinations. It is procured either from the native sulphate of barytes, by exposing its powder to a red heat with charcoal, and by forming from the resulting sulphuret a nitrate, which is decomposed by heat; or from the native carbonate, by dissolving it in nitric acid, and, in like manner, subjecting it to heat.

Barytes has a specific gravity of 4, is of a gray colour, has a caustic taste, and slakes on exposure to the air, like lime, falling to powder by the absorption of water. It is soluble in 25 parts at 60°, and in the proportion of nearly half its weight at 212°. The solution, on cooling, affords prismatic crystals. Its watery solution possesses distinct alkaline properties, changing the vegetable blues to green, and acquiring a film upon its surface, when exposed to the air, from the absorption of carbonic acid. It operates as a virulent poison when taken into the stomach. To the flame of alcohol it imparts a yellow colour, which, together with its great solubility in water serve to distinguish it from the other earths. It is useful in chemical analysis, in consequence of its property of uniting by fusion with several of the earths and metallic oxydes, and rendering them soluble in acids or water.

Barytes has been decomposed by the agency of galvanism, and ascertained to be the oxyde of a peculiar metal, *Barium*, of a white colour, with a metallic lustre, resembling silver. Exposed to the air, or thrown into water, it reabsorbs oxygen, and is converted into barytes which combines with the acids, and forms a variety of salts, two of which, the *carbonate* and the *sulphate*, are found abundantly in nature. The first of these, *Witherite*, is commonly fibrous, or bladed in its structure, occasionally including small cavities lined with minute crystals. It is whitish, translucent, and glistening. Specific gravity, 4·3. It is composed of barytes, 78, and carbonic acid, 22. It is used to obtain the pure barytes, and those salts of this earth which are employed as chemical tests, and for the purposes of scientific illustration.

The sulphate called in mineralogy *heavy-spar*, is found abundantly, usually accompanying galena, or common lead ore, of which it frequently forms the gangue. It is often beautifully crystallized under a variety of forms. It consists of 67 parts barytes, and 33 sulphuric acid. It is employed, though less extensively, for the same purposes as the carbonate.

A fibrous variety of heavy-spar, called *Bolognian-stone*, and which occurs, imbedded in small nodular masses, in a marl near Bologna, has the remarkable property of becoming phosphorescent by calcination.

The *artificial* sulphate of barytes, formed by adding sulphuric acid to the carbonate of barytes, is employed for the purpose of painting in water-colours, and is the most beautiful white now in use. It is known by the name of *permanent white*. The same substance is much valued for marking bottles in chemical laboratories, where the acid vapours destroy common ink, and for labelling articles kept in cellars and moist places. It is mixed with spirits of turpentine and linseed-oil, to the consistence of common paint, when it is laid on with a brush. If a black marking material is preferred, this may be rendered so, by the addition of a little lampblack.

*Nitrate of barytes*, is formed by dissolving the native carbonate in diluted nitric acid, and crystallizes on evaporation. It is soluble in 10 or 12 parts of water, at 60°, and in 3 or 4 parts at 212°.

*Muriate of barytes*, in like manner, is produced by submitting the carbonate to the action of dilute muriatic acid.

Both these salts are of great importance in analytical processes, for the detection of sulphuric acid; barytes forming, with that acid, an insoluble precipitate, while the nitric or muriatic acid neutralizes the base.

*Barytes, muriate of, (chloride of barium)* is made by dissolving carbonate of barytes, or rats' stone, 1 lb. in muriatic acid 1 lb., previously mixed with water 3 lbs. then filter and crystallize by repeated evaporation.

Or, mix sulphate of barytes, (cawk) 2 lbs. with charcoal 4 ozs.; keep it red-hot in a covered vessel for six hours, boil the mass in water 8 lbs., strain, and to clear the liquor add muriatic acid as long as it produces any effervescence; lastly, crystallize by evaporation.

*Barytes, acetate of*, is made by dissolving carbonate of barytes in acetic acid, evaporating and crystallizing.

*Barytes Water*. Dr. Henry recommends Pelletier's process for making it. The carbonate of barytes, found in various parts, is powdered, and mixed up with an equal measure of wheat flour, and a little water, into a ball. A crucible is then filled one-third of its height with charcoal dust, the ball placed on this bed, and covered with more charcoal dust. A cover being luted on the crucible, it is exposed to a most violent heat for two hours. When cold, the ball is to be flung into water, the barytes will dissolve, and the solution is to be filtered.

Barytes water is used to detect the presence of carbonic acid in mineral waters. It is also used to discover sulphuric acid in any liquid, as it forms a sediment which is not soluble in muriatic acid.

*Nitric solution of barytes.*
*Muriatic solution of barytes.*
*Acetic solution of barytes.*

These are also called, respectively, *nitrate of barytes*, *muriate of barytes*, and *acetate of barytes*, and are prepared by dissolving the natural carbonate of barytes in the respective acids.

They are used to discover the presence of sulphuric acid in mineral waters.

BASALT, a rock usually found in columns, as at Fingal's Cave, the Giants Causeway, with a specific gravity of 3. It is found among primitive rocks, and generally considered of volcanic origin. At Fairhead they are 250 feet high, in hexagonal columns and exactly fitting. It consists of silex 48, alumina 16, oxide of iron 16, lime 9, soda 4, muriatic acid 1, water, &c. 5. Calcined it makes good morter, and it has been formed into wine-bottles only by adding soda.

BASE, is that substratum of body which in combination with known elements, forms a regular compound in definite proportions of the element and the base. It is the atoms which unite, and not the gross masses. When oxygen forms a metal into the powder of an oxide, the most minute portion consists of the oxygen element, and the metallic base. The union changes the characters of both in the visible and other qualities of the compound; sometimes, too, the united bulk is greater, but in general less than the sum of the separate volumes. When united no mechanical means will separate them, and even heat does but facilitate a new combination by which one may be left separate. Some bodies unite with others readily, and with others with difficulty, owing to some accordance or discordance in their atomic motions, and of this chemists take advantage in separating the elements of acids, salts, &c. from their bases.

There are 18 bases, which form acids in combination with oxygen or its species, as hydrogen, nitrogen, carbon, sulphur, phosphorus, &c. &c. 13 metals, so alkaline that they combine with a certain proportion of oxygen, in the ordinary state of the atmosphere, and form the alkaline earths. 18 metals, which preserve the metallic state, but susceptible of combination with oxygen, &c. by heat or combustion.

BASES, in chemistry, are those bodies which, when united with oxygen and its compounds in air, and the other supporters, form acids or alkalies, called *acidifiable* or *alkalinical* bases.

The cause of the difference appears to be that as neutralized atmospheric air, in which they subsist, consists of 1 oxygen, 3·5 nitrogen, by weight, an accommodation to this standard becomes necessary; hence when a body has too much oxygen, or its due proportion as above, further addition of oxygen, or its compounds, acidifies it; but when it is already too alkaline, oxygen produces neutrality, and an oxide or earth in which acidity is not evident. This creates a generic difference in the two.

Thus we may regard carbon as a neutral body, which oxygen converts into carbonic acid; and potassium as an alkali, which oxygen reduces to the standard of 3·5 to 1 in potass.

The *acidifiable* bases are the gases hydrogen and nitrogen, and the intractable black powders carbon, silicon, and boron. The volatile substances phosphorus, sulphur, selenium, arsenic, antimony, and tellurium. And chromium with 6 other new laboratory metals. All with such an excess, or such neutral state of oxygen, that more of it acidifies them.

The *alkalinical* bases are potassium, and the 6 metallic substances formed from alkalies by the galvanic shock which protrudes or explodes their previous oxygen, with 6 others, alumine, &c. which form white earths when oxydated. Iron, nickel, cobalt, manganese, when oxydated, yield only to mere acids. The 14 other metals oxidate in various degrees. But all these bodies, 31 in number, produce oxides without acidity, because in their metallic state they consisted of more alkali than the atmospheric or neutral proportion of 3·5 to 1.

Higher proportions of oxygen than are necessary to produce the stable condition of the bodies, are called acids; and as each of the supporters modifies the result, and some of the acidifiable bases acidify the alkaline bases, the acids are 98 in number, of which 36 are oxygen with a base as above, and 62 are formed by oxygen in combination with carbon and hydrogen, and in a few with nitrogen and sulphur.

These acids, then, in combination with bases in alkalies, earth, and metallic oxides, form the immense varieties of salts, soluble in water, saline in taste, and not inflammable. These bases are 51 in number, and known in degree of strength by the termination *ate* or *ite* being added to the acid, or *bi* or *bis* prefixed, to show a precise double acidity, or *ter* a precise triple, or *sesqui* for $1\frac{1}{2}$ of the acid, or only half *dis*, or a third *tris*. Differences easily remembered.

There can be no reasonable doubt but that the *ores* of all metals are formed by the oxygen and nitrogen of electrical action, the substrata or base of each being particles of the adjacent rocks; and that the qualities of ductility and malleability arise from the silex, or argil, which prevails in the forming rocks. The *ore* is rendered *metal* by our driving off the oxygen.

BASKETS, are made of osiers, twigs, or reeds, and are light, useful, and durable articles. Osiers grow near running water, and are very profitable plantations, having from 8 or 10 plants per yard. They are used entire for coarse work, or peeled with a brake after being soaked in water. For fine work, they are *split* into four by a suitable tool; and again reduced to *skains* by other tools. These are put together in the manner of weaving by hand, and have their warp and woof. The skains are often dyed or stained, and the colours intermingled with taste. The species of osier which answer best is the gray, or brindled, with red streaks in the bark. The French willow is also esteemed for all fine work. They are planted with best effect in October, by shoots. The consumption for baskets of various kinds is immense, and they employ many thousands of the poor.

BASS-RELIEF (Ital. *basso reliero);* synonymous with *relief;* figures, more or less elevated, in stone, plaster, clay or metal, upon a flat surface. *Bass-relief* properly signifies the least elevation; *haut-relief*, or *alto relievo*, the highest, in which the figures project half of their apparent circumference from the back-ground. Among the famous modern bass-reliefs are those of Bandurli, Ghiberti, and Lucca della Robbia, at Florence. And some of the finest bass-reliefs are by Canova and Thorwaldsen.

BASSOON; an instrument which forms the natural bass to the hautboy. It is played, like that instrument, with a reed, and forms a continuation of its scale downwards. The reed is fixed to a crooked mouth-piece, issuing from the side of the bassoon. There, keys communicate to the ventages, which otherwise are too remote for fingering. It is now so far improved with keys as to be susceptible of being played solo. Its compass is three octaves, from double A in the bass to *a* in the second space of the treble; and its designation generally is the F or bass-clef; yet, in the higher passages, for the more convenient arrangement of the notes, the alto, or tenor-clef, is often used. It consists of four tubes, bound together like a fagot. Hence the Italians term it *fagotto*, and from them the Germans *fagott*. In music designed for wind-instruments, it usually forms the bass. There is a modification of this instrument, much lower and stronger in its tones,—the bass-horn,—which, in field music, has of late been substituted for the serpent.

BATEMAN'S PECTORAL DROPS.—To one quart of alcohol add 2 ozs. of fenugreek seed, and 6 drs. of aniseed; with water to supply by distillation five pints of liquid, and mix with 4 drs. of opium, 3 drs. of camphor, 2 scruples of subcarbonate of potass, and two drams of red coral.

BATES' ALUM-WATER, is a valuable combination of alum with 7 grs. of sulphate of zinc; and it is a powerful astringent, used for old ulcers, as an eye-water, in gleets, and in removing chilblains, &c.

BATES' ANODYNE BALSAM. In two pints of alcohol, mix half an ounce of oil of rosemary, 2 ozs. of camphor, 1 oz. of opium, and 4 ozs. of white soap.

BATH; a city, in Somersetshire, England. The Romans called it *Aquæ Solis*, *Fontes Calidi*, *Thermæ*, *Bodonia*, and *Bathonia*; the Britons, *Caer Badun*, or *Bladon*; the Saxons, *Hat Bathun*, and *Achamannum*. Bath is remarkable for medicinal waters, for its various sources of amusement, for the elegance of its streets, and the magnificence of its public buildings. There are five public baths, *viz*. King's and Queen's bath, Cross bath, Hot bath, and New Private bath. The temperature of the different springs varies from 93° to 117° Fahrenheit. That of the King's bath is 116°, that of the Hot bath 117°, and that of the Cross bath 111°. They contain carbonic acid, azotic gas, muriate and sulphate of soda, carbonate and sulphate of lime, with a very small quantity of silex and oxycarbonate of iron. They are found of great efficacy in cases of gout, rheumatism, indigestion, palsy, and biliary obstructions. In fact, they are alkaline solutions, applied to the skin, and thereby increase the excitement and energy of respirable action.

BATHING, a most salutary practice, whether hot or cold, in fresh water or salt, or simply washing the whole body with a wet towel at rising in the morning. It cleanses the skin, removes the ammoniacal smell of perspiration, and produces a healthy action of the pores, both as to perspiration and the essential absorption of nitrogen. It is also a general security against rheumatism, and if followed by the friction of a brush or a very rough towel, gives tone and vigour to the whole animal system. It is to a man or woman equivalent to grooming a horse, and it is almost a miracle if health is enjoyed without it.

BATHS, Greek and Roman. The building which contained them was oblong, and had two divisions, the one for males, the other for females. In both, warm or cold baths could be taken. The warm baths, in both divisions, were adjacent to each other, for the sake of being easily heated. In the midst of the building, on the ground-floor, was the heating-room, by which not only the water for bathing, but sometimes also the floors of the adjacent rooms, were warmed. Above the heating-room was an apartment in which three copper kettles were walled in, one above another, so that the lowest was immediately over the fire, the second over the first, and the third over the second. In this way, either boiling, lukewarm, or cold water could be obtained. The water was carried, by separate pipes, provided with cocks, from these kettles into the bathing-rooms, and a fresh supply was immediately poured into the kettles from a reservoir.

The baths of Dioclesian had accommodations for 1800 persons. There were six apartments for each, the hot, the tepid, and the cold, the undressing-room, the sweating-room, and the perfuming-room. There was also a waiting-room. There were 850 in Rome. The imperial ones were lavishly decorated with statues, basso-relievos, and pictures. All nations practise bathing more than the English.

Among Europeans, the Russians have peculiar establishments for bathing, which are visited by all classes of the people during the whole year. The Russian bath consists of a single hall built of wood. In the midst of it is a powerful metal oven, covered with heated stones. Round about there are broad benches. In entering this hall, you encounter such a heat, that one who is not accustomed to it can bear it but a few moments. Those, however, who can endure it for some time, undress, and stretch themselves on a mattrass upon one of the benches. Cold water is then poured on the heated stones; a thick hot steam rises, which envelopes the bather, and heats him to such a degree, that the sweat issues from his whole body. The thermometer, in this steam, usually rises to 122° or 142° Fahrenheit. The people regard these baths as a necessary of life, and they are to be found almost throughout the Russian empire. Among Asiatics, baths are in general use. The Turks, by their religion, are obliged to make repeated ablutions daily: besides these, men and women must bathe in particular circumstances and at certain times.

A peculiar kind of baths are used in the East Indies, called *Shampooing*. An attendant stretches the bather upon a table, pours over him warm water, and begins, afterwards, with admirable skill, to press and to bend his whole body. All the limbs are extended, and the joints made to crack. After he has done with one side, he goes on with the other; now kneels upon the bather; now takes hold of his shoulders; now causes his spine to crack, by moving the vertebræ; now applies gentle blows to the fleshy and muscular parts. After this, he takes a cloth of hair, and rubs the whole body, removes the hard skin from the feet with pumice-stone, anoints the bather with soap and perfumes, and finishes by shaving and cutting his hair. This treatment lasts about three quarters of an hour, and produces the greatest refreshment. An agreeable feeling pervades the whole body, and ends with a slumber of several hours.

Public baths are common in Europe, and there are, at present, few cities without them. Medicine has endeavoured to increase the wholesome effects of baths by various compositions and methods of application. Baths are distinguished by the nature of the fluid, by the degree of heat, and by their influence upon the body. They are prepared with water, milk, wine, &c.; are of different temperatures; and herbs, iron, soap, and other substances are mixed with them, as the purpose requires. There are, also, baths of earth, sand, air, vapour, and electric baths. They are applied either to the whole body, or only to a single part. The shower bath affords an agreeable and healthful mode of bathing, and much use is made of it in medicine. Mineral baths are those, the water of which naturally contains mineral ingredients.

Bathing is a salutary practice with a view to keep the skin clean, and in healthy action, rendered still more important by the consideration that the nitrogen of the atmosphere reacts by the pores of the skin on the blood in the veins. But a formal bath is not necessary, every purpose being effected by a wash-hand basin, or bidet, a wet flesh-brush, and wet and dry very rough towels, either on going to bed, or on rising in the morning, or both. Nor is cold water necessary, since the sole object is a clean and well-rubbed skin.

When formal baths are used, the natural cold bath is from 32° to 65°, the tepid from 65° to 80°, the warm 95° to 105°, and the vapour from 105° to 125° or 130°. The latter are more efficacious, only because they more effectually cleanse the skin, and increase the action and reaction of the arterial and venous blood.

In general, health is preserved by so much friction with a flesh-brush, and rubbing with rough towels on going to bed, as reduces the heat of the skin from clothing, or eating and drinking, to the average temperature. Sound sleep will follow. But in the morning, ablution should be general, and soap and water be used wherever secretions are greatest. Good spirits and appetite will result through the day. Ten minutes of such washing, brushing, and rubbing is an exercise equivalent to a walk of five or six miles. Salt may occasionally be used in the water, and better still, some sub-carbonate of soda or alum, to increase the nitrogenous action of the skin.

*Warm baths.*—The best materials for warm baths are slabs of polished marble, properly bedded with good water-tight cement, in a seasoned wooden case, and carefully united at their edges. Large Dutch tiles, or square pieces of white earthernware, are sometimes substituted. Copper or tinned iron-plate are also used; the former is more expensive, but far more durable than the latter, unless excellently made. Wooden tubs, square or oblong, and oval, are sometimes used for warm baths, but wood contracts a mouldy smell; and there is difficulty in keeping them water-tight. Others are made of tin, but apt to get rusty.

The basement story should always be avoided; and the fittest place for warm baths are dressing-rooms annexed to principal bed-rooms; or, where such convenience can be obtained, a separate bath-room connected with the dressing-room.

*Sand baths*, for digestions and other purposes of tempered heat, should consist of clean sea-sand, and be made of cast-iron, as less subject to warp than wrought-iron.

BATISTE; cambric; a very fine, thick, white linen cloth. It is made of the best white flax, called *ramé*, which is cultivated in the French Hainault. In the 13th century, this manufacture is said to have been brought into vogue by Baptista Chambrai, in Flanders, and the linen afterwards received from him the name of *batiste*, or *cambric*.

BATTENS, are narrow boards, or broad deals, sawed down the middle.

BAZAAR; an oriental market-place, adopted in England for the purpose of getting multiplied rents from large buildings, otherwise useless, and serving as a covered promenade for idle persons.

BEAMS, Transverse Strength of. The rules are, 1. That beams of the same depth are to each other as their breadths. 2. That beams of equal breadths are to each other in strength as the squares of their depths. 3. That beams of equal dimensions are to each other *inversely* as their lengths. 4. That the strength of all beams is directly as their breadths, and the square of their depths, or, if cylinders, as the cubes of diameters; and, inversely, as their lengths.

The relative transverse strength of timber is as under:—

| | |
|---|---|
| Eng. Oak . | . 1426 |
| Canada ditto | . 1766 |
| Ash . . | . 2026 |
| Beech . . | . 1556 |
| Fir . . | . 1100 |
| Larch . . | . 1127 |

It often happens that the weight to be supported is known, and that the size of a beam is required of either of these timbers, or the size is known and power required. In these cases, the number standing against the timber, multiplied by the breadth and square of the depth in inches, is *equal* to the length in inches by the number of lbs. which the beam will just bear, as a lever, with the weight or load at one end.

If the load is equally spread over the length, then half the length in inches may be taken, or half the weight, since a beam will support double on its whole length that it will at its end.

If supported at both ends, and the load is laid on the centre, then the equation is the tabular number (as 1100 for fir,) multiplied by four times the breadth, and the square of the depth in inches *equal* to the length in inches, multiplied by the number of lbs.

If so supported, the load is on the whole length; it will support double.

Owing to changes of weather, &c. the constant load should not exceed two-thirds what the beam is calculated to bear.

When a rule is given by equality it is most easy to vary either of the proportions or numbers, so as to preserve the equality. Thus, if $3 \times 4 \times 8 = 6 \times 16 = 96$, if we want 16; and to be 32, we can vary 3, or 4, or 8, so as to preserve the equality. For if 16 became 32, then $6 \times 32$ would be 192, and we may vary 3, or 4, or 8, or all, so as to make 192.

When cast-iron beams are used to bear a weight in the middle, the product of the length in feet between the supports by the weight in lbs. is *equal* to 850, multiplied by the breadth in inches, and the square of the depth in inches. Hence, if any three of the four quantities are given, the fourth may be found.

When beams are inclined, the horizontal length should be taken, as the force of weight is at right angles to the horizon.

A beam of cast-iron, 20 feet long, 15 inches deep, and 3·045 broad, will carry 13 tons in the middle. A beam will carry 10 tons in the middle which is 30 feet long, $11\frac{1}{2}$ deep, and $5\frac{1}{2}$ broad.

A square inch of oak, 58 feet long, will break by its own weight. And a similar bar of iron in $38\frac{1}{4}$ feet. Iron is $4\frac{1}{2}$ times stronger than oak but $7\frac{1}{2}$ times heavier.

Oak will suspend much more than fir, but fir will support twice as much as oak.

These and other problems are worked at length in *Barlow on Timber*, *Brunton's Compendium*, and *Buchanan's Essay on Shafts*, &c.

BEAVER, (*castor*, L.;) a genus of interesting quadrupeds. In a state of nature the beaver displays those rational modes of acting which have so long rendered the species celebrated. They are not particular as to the site which they select for the establishment of their dwellings, but if it is in a lake or pond, where a dam is not required, they are careful to build where the water is sufficiently deep. In standing waters, however, they have not the advantage afforded by a current for the transportation of their supplies of wood, which, when they build on a running stream, are always cut higher up than the place of their residence, and floated down. The materials used for the construction of their dams are the trunks and branches of small birch, mulberry, willow, and poplar-trees, &c. They begin to cut down their timber for building early in the summer, but their edifices are not commenced until about the middle or latter part of August, and are not completed until the beginning of the cold season. The strength of their teeth, and their perseverance in this work, may be fairly estimated by the size of the trees they cut down. Best saw a mulberry-tree, eight inches in diameter, which had been gnawed down by the beaver; and trees are commonly felled by these animals, at least five or six inches in diameter. The trees are cut in such a way as to fall into the water, and then floated towards the site of the dam or dwellings. Small shrubs, &c. cut at a distance, they drag with their teeth to the stream, and then launch and tow them to the place of deposit. At a short distance above a beaver dam, the number of trees which have been cut down is truly surprising, and the regularity of the stumps might lead persons, unacquainted with the habits of the animal, to believe that the clearing was the result of human industry. The figure of the dam varies according to circumstances. Should the current be very gentle, the dam is carried nearly straight across; but when the stream is swift, it is uniformly made with a considerable curve, having the convex part opposed to the current. Along with the trunks and branches of trees they intermingle mud and stones, to give greater security; and, when dams have been long undisturbed and frequently repaired, they acquire great solidity, and their power of resisting the pressure of water, ice, &c. is greatly increased by the willow and birch occasionally taking root, and eventually growing up into something like a regular hedge. The materials used in constructing the dams are secured solely by the resting of the branches, &c. against the bottom, and the subsequent accumulation of mud and stones by the force of the stream, or by the industry of the beavers. The dwellings of the beavers are formed of the same materials as their dams, are very rude, and adapted in size to the number of their inhabitants: seldom more than four old, or six or eight young ones, are found in one of the lodges, though double that number have been sometimes seen. In building their houses, they place most of the wood crosswise, and nearly horizontally, observing no other order than that of leaving a cavity in the middle. Branches projecting inwards are cut off with their teeth, and thrown among the rest. The houses are not of sticks, and then plastered, but of all the materials used in the dams—sticks, mud, and stones, if the latter can be procured. This composition is employed from the foundation to the summit. The mud is obtained from the adjacent banks, or bottom of the stream or pond, near the door of the hut.

The beaver always carries mud or stones, by holding them between his fore paws and throat. Their work is all performed at night, and with much expedition. When straw or grass is mingled with the mud used in building, it is owing to the nature of the spot whence the mud is obtained. As soon as any portion of the materials is placed, they turn round, and give it a smart blow with the tail. The same sort of blow is struck by them on the surface of the water when they are in the act of diving. The outside of the hut is covered or plastered with mud, late in the autumn, and after frost has begun to appear. By freezing, it soon becomes almost as hard as stone, effectually excluding their great enemy, the wolverene, during the winter. Their habit of walking over the work frequently, has led the absurd idea of their using the tail as a trovel.

The houses are generally from four to six feet thick at the apex of the cone; some have been found as much as eight feet thick at top. The door or entrance is always on the side farthest from land, and is near the foundation, or a considerable depth under water: this is the only opening into the hut. The large houses are sometimes found to have projections of the main building thrown out, for the better support of the roof, and this circumstance has led to all the stories of the different apartments in beaver huts. These larger edifices, so far from having several apartments, are double or treble houses, the parts having no communication except by water. The musk-rat sometimes takes lodgings in the huts of the beaver. The otter, also, occasionally intrudes: he, however, is a dangerous guest, for, should provisions grow scarce, it is not uncommon for him to devour his host. All the beavers of a community do not co-operate in fabricating houses for the common use of the whole. The only affair in which they have a joint interest, and upon which they labour in concert is the dam. Beavers also make excavations in the adjacent banks, at regular distances from each other, which have been called washes. These are so enlarged within that the beaver can raise his head above water to breathe without being seen, and, when disturbed at their huts, they immediately swim under the water to these washes for greater security.

The food of the beaver consists chiefly of the bark of the aspen, willow, birch, poplar, and, occasionally, alder: to the pine it rarely resorts, unless from severe necessity. They provide a stock of wood from the trees first mentioned, during summer, and place it in the water, opposite the entrance into their houses.

The beaver produces from two to five at a litter. It is a cleanly animal, and always performs its evacuations in the water, at a distance from the hut: hence no accumulation of filth is found near their dwellings. The beaver is about two feet in length; its body thick and heavy; the head compressed, and somewhat arched at the front, the upper part rather narrow; the snout much so. The eyes are placed rather high on the head, and the pupils are rounded; the ears are short, elliptical, and almost concealed by the fur. The skin is covered by two sorts of hair, of which one is long, rather stiff, elastic, and of a gray colour for two-thirds of its length next the base, and terminated by shining reddish-brown points; the other is short, thick, tufted, and soft, being of different shades of silver-gray or light lead-colour. The hair is shortest on the head and feet. The hind-legs are longer than the fore, and are completely webbed. The tail is 10 or 11 inches long, and, except the third nearest the body, is covered with hexagonal scales. The third next the body is covered with hair like that on the back.—*Godman's Nat. Hist.*

BEAUME'S HYDROMETER. This has a reference to water as unity; and its great convenience, and the ease with which it may be constructed, have brought it into universal use. There are two: one for liquids *lighter* than water, the other *heavier*. In both, the floating point of the instrument is distilled water, or a solution of one ounce of salt in nine of water.

The instrument is poised, so that the 0 of the scale is at the bottom of the stem in the saline solution, and the depth to which it sinks in distilled water shows the 10th degree.

FOR LIGHT FLUIDS, OR SPIRITS.

| *Beaumé.* | *Sp. Gr.* | *Beaumé.* | *Sp. Gr.* | *Beaumé.* | *Sp. Gr.* |
|---|---|---|---|---|---|
| 50 | 0·782 | 36 | 0·847 | 22 | 0·923 |
| 49 | 0·787 | 35 | 0·852 | 21 | 0·929 |
| 48 | 0·792 | 34 | 0·858 | 20 | 0·935 |
| 47 | 0·796 | 33 | 0·863 | 19 | 0·941 |
| 46 | 0·800 | 32 | 0·868 | 18 | 0·948 |
| 45 | 0·805 | 31 | 0·873 | 17 | 0·954 |
| 44 | 0·810 | 30 | 0·878 | 16 | 0·961 |
| 43 | 0·814 | 29 | 0·884 | 15 | 0·967 |
| 42 | 0·819 | 28 | 0·889 | 14 | 0·974 |
| 41 | 0·823 | 27 | 0·895 | 13 | 0·980 |
| 40 | 0·828 | 26 | 0·900 | 12 | 0·987 |
| 39 | 0·832 | 25 | 0·906 | 11 | 0·993 |
| 38 | 0·837 | 24 | 0·911 | 10 | 1·000 |
| 37 | 0·842 | 23 | 0·917 | | |

For liquids heavier than water, the position of the fixed points is reversed; the 0 is at the top of the stem, and denotes the level to which the hydrometer sinks in distilled water: the 10th degree is lower down, and shows the level to which it sinks in the saline solution.

FOR HEAVY FLUIDS.

| *Beaumé.* | *Sp. Gr.* | *Beaumé.* | *Sp. Gr.* | *Beaumé.* | *Sp. Gr.* |
|---|---|---|---|---|---|
| 1 | 1·007 | 26 | 1·221 | 51 | 1·549 |
| 2 | 1·014 | 27 | 1·231 | 52 | 1·566 |
| 3 | 1·022 | 28 | 1·242 | 53 | 1·583 |
| 4 | 1·029 | 29 | 1·252 | 54 | 1·601 |
| 5 | 1·036 | 30 | 1·261 | 55 | 1·618 |
| 6 | 1·044 | 31 | 1·275 | 56 | 1·637 |
| 7 | 1·052 | 32 | 1·286 | 57 | 1·656 |
| 8 | 1·060 | 33 | 1·298 | 58 | 1·676 |
| 9 | 1·067 | 34 | 1·309 | 59 | 1·695 |
| 10 | 1·075 | 35 | 1·321 | 60 | 1·714 |
| 11 | 1·083 | 36 | 1·334 | 61 | 1·736 |
| 12 | 1·091 | 37 | 1·346 | 62 | 1·758 |
| 13 | 1·100 | 38 | 1·359 | 63 | 1·779 |
| 14 | 1·108 | 39 | 1·372 | 64 | 1·801 |
| 15 | 1·116 | 40 | 1·384 | 65 | 1·823 |
| 16 | 1·125 | 41 | 1·398 | 66 | 1·847 |
| 17 | 1·134 | 42 | 1·412 | 67 | 1·872 |
| 18 | 1·143 | 43 | 1·426 | 68 | 1·897 |
| 19 | 1·152 | 44 | 1·440 | 69 | 1·921 |
| 20 | 1·161 | 45 | 1·454 | 70 | 1·946 |
| 21 | 1·171 | 46 | 1·470 | 71 | 1·974 |
| 22 | 1·180 | 47 | 1.485 | 72 | 2·002 |
| 23 | 1·190 | 48 | 1·501 | 73 | 2·031 |
| 24 | 1·199 | 49 | 1·516 | 74 | 2·059 |
| 25 | 1·210 | 50 | 1·532 | 75 | 2·087 |

It requires several ounces of liquor to float. In very small quantities ascertain how many grains of distilled water is held by a very light bottle, when filled to a mark in the neck, and how many grains the bottle holds of the liquid in question. Then, as the weight of the water is to that of the liquid, so is the specific gravity of water to that of the liquid.

*Specific gravities and degrees of Beaumé of the most usual liquids.*

LIGHT FLUIDS.

| *B.* | *Sp. Gr.* | |
|---|---|---|
| | 0·700 | Hydrocyanic acid. |
| | 0·715 | Pure ether. |
| 43 | 0·815 | Alcohol. |
| 36 | 0·847 | Naphtha. |
| 32 | 0·868 | Spirit of turpentine. |
| 23 | 0·915 | Olive oil. |
| 22 | 0·923 | Strong brandy. |
| 17 | 0·958 | Boiling water. |
| 16 | 0·960 | Liquid ammonia. |
| 10 | 1·000 | Distilled water. |

HEAVY FLUIDS.

| *B.* | *Sp. Gr.* | |
|---|---|---|
| 1 | 1·007 | Distilled vinegar. |
| 4 | 1·029 | Good milk. |
| 8 | 1·060 | Wort for table ale, or malt spirit. |

| B. | Sp. Gr. | |
|---|---|---|
| 10 | 1·075 | Standard brine. |
| 13 | 1·100 | Wort for strong ale. New-laid egg. |
| 20 | 1·160 | Muriatic acid. |
| 35 | 1·321 | Cold saturated syrup. |
| 41 | 1·398 | Common nitric acid. |
| 67 | 1·872 | Sulphuric acid. |

BEAUTY, in order, is the square, parallelogram, and oval, straight lines, regular flexures, and curves.—*Wren.*

Hogarth calls all curves the lines of beauty, and in gardening and painting they are preferred. Other estimates of the beautiful are connected with associations of flavour, use, or end. Thus men see beauty in women, and women beauty in men; not men in men, nor women in women. A beautiful country is associated with ideas of enjoyment.

BEAUTY WATER, a wash for the face, made by distilling a lb. each of thyme and marjoram-flowers, with five quarts of proof spirits, and one of water.

BEDSTEADS OF WIRE GAUZE.—Breidenback, of Birmingham, claims the application of wire-gauze as a substitute for the sacking, head, tester, and the various hangings of a bedstead; with a view of preventing certain insects from establishing their domicile, and the intrusion of divers insects and reptiles between the tropics. In lieu of the ordinary curtains, the wire-gauze will be framed into panels, and connected together by hinges, so as to allow any of them to be opened at pleasure. The sacking, head, and tester may, however, be permanently fixed.

Cool beds, for summer or for hot climates, are made of caoutchouc, inflated with air. They are light, soft, and durable.

Feathers are less wholesome for beds than horse-hair or flock mattrasses, which are generally used.

BEECH, a hardy tree, which flourishes on chalk-hills and downs, and whose tough wood is indispensable for many purposes. But no herbage grows under it.

BEER, for the table. Take 8 bushels malt, 8 lbs. hops, 8 lbs. sugar, made into colour, and Spanish liquorice 8 oz., treacle 10 lbs. The produce is 10 barrels.

*Barley Wine*, or *Ale*, is made of 14 quarters pale malt, mashed at three times, with 28, 18, and 18 barls. of water, boiled with 112 lbs. hops, set with 36 lbs. of yeast, cleansed with 4 lbs. of salt, and it produces 34 barls. or 1 gal. 1 pint of ale from each gallon of malt.

*Table Ale*, is made of very pale malt 12 quarters, mashed at three times with 46, 32, and 32 barls. of water; then boiled with 62 lbs. hops, set with 114 lbs. of yeast, cleansed by the yeast head being beat in, and let to work out. The produce is 100 barls. or 4 gals. ale from each gallon of malt.

*Treacle Beer*, is made of hops $1\frac{1}{4}$ lb. boiled in 36 gals. of water, for an hour, add 14 lbs. treacle, and a little yeast; ferment and bottle.

*White Spruce Beer*, is made by infusing in water 10 gals., sugar 6 lbs., essence of spruce 4 oz., and adding yeast. Bottle immediately in half pints. In *Brown Spruce Beer* using treacle instead of sugar.

*To make Ginger Beer.*—Take lump-sugar 3 lbs., bruised ginger 2 oz., cream of tartar 1 oz., lemons sliced 4; and pour on them 4 gals. boiling water. Add yeast half-a-pint, work for four days, then bottle in half pints, and tie down the corks.

*Mum*, is liquor brewed from wheat malt.

*Imperial Pop*, is made by mixing cream of tartar 3 oz., ginger 1 oz., white sugar $1\frac{1}{2}$ lbs., lemon juice 1 oz., water $1\frac{1}{2}$ gal., yeast 1 oz. Bottle, and tie down the corks.

*Parsnip Wine*, or *Malmsey*, is made by cutting the roots into thin slices, and boiling them in no more water than will just cover them. Then press out the liquor and ferment.

*Beer from potatoes.*—Dr. Hare having observed that there is a strong analogy between the saccharine matter of the sweet potato and molasses, or the saccharum of malt, was induced to boil a wort made from the potato, of 1060 degs. specific gravity, with a proportionate quantity of hops, for the space of 2 hours. It was then cooled to about 56 degs. and yeast added. As far as he could judge, the phenomena of the fermentation and the resulting liquor were precisely the same as if malt had been used. The wort was kept in a warm place until the temperature was 85 degs. Fahr.; and the fall of the head showed the attenuation to be sufficient. Yeast subsequently rose, which was removed by a spoon. By refrigeration, a further quantity of yeast was precipitated, from which the liquor being decanted became tolerably fine for new beer, and in flavour exactly like ale made from malt. Dr. Hare has computed that 5 bushels of potatoes would produce as much wort as 3 bushels of malt.

In malt liquors, 6 lbs. sugar is esteemed equal in strength, and 1 lb. coriander seed, in intoxicating power, to a bushel of malt. The sugar employed is burnt to colour the beer instead of brown malt, and it has been proposed to employ roasted coffee for this purpose. It is necessary to malt only one-third of the corn, as this portion will convert the other into its own nature during the process.

Capsicum and grains of paradise are used, to give a pungent taste to weak beer, but, to avoid detection, concentrated tinctures are mostly used; and ginger, coriander seed, and orange-peel are used to flavour it: besides these, opium, cocculus indicus, nux vomica, tobacco, and extract of poppies, are used to increase the intoxicating quality. Quassia is employed instead of hops as a bitter, but as this does not precipitate the mucilage, the beer soon grows muddy, unless kept very cool.

Mild or new beer is made to taste like stale by adding a little oil of vitriol, or some alum; and, on the other hand, stale or sourish beer is made to resemble mild by neutralising the acid by oyster-shells or chalk.

When strong beer is reduced by adding small beer, publicans usually add molasses to enable it to form a head, and extract of gentian to keep up the flavour.—*Gray.*

*Heading for Beer*, is made of equal weights of alum and copperas.

BEER-DRAWING MACHINES, are pipes, attached to the bottom of barrels, in a cellar, with a piston worked with a handle. They ought never to be of lead or copper, and caoutchouc has been recommended, as cheap and durable.

BEES, are insects of extraordinary sagacity and industry, subject to the controul and management of man, for whom, with kind treatment, and due regard to preservation, they provide Honey and Wax, articles of the first necessity to human enjoyment. Before the intercourse with the tropical regions, and the cultivation of beet-root, their products were of still higher importance; but, as they collect their stores from what is otherwise useless, they add their entire produce to domestic wealth, and merit, therefore, the attention, kindness, and gratitude, of those whom they enrich. The means of robbing them, without actual injury, are now generally practised, though there are persons who still add murder to robbery, and whose consciences are no protection to the poor bees. In this case, however, there is punishment in loss of profits, for all accumulated profits on bees depend on their careful preservation from season to season. Their history, their habits, &c. are objects of great interest, but foreign to the objects of this work.

Their cells contain the greatest space with the same materials. They are exactly hexagonal, and the obtuse angles are 109° 28′ 16″, and the other the complement of 180° or 70° 31′ 44″. This economy must be the result of equality of right to an equal space, and the geometric necessity which governs the structure on that principle. Of their acute reasoning powers no doubt can be entertained. Every thing is system, though in fixed habits they resemble the Chinese and Hindoos as to general results. The barbarous system of destroying them, to plunder their hives (robbery and murder) is now abolished, or is practised only by the most ignorant and debased of the human race, whose moral feelings are on a level with those of the midnight assassin. It is now usual to place an empty hive or box over a full one with an aperture, and when the bees have risen into it, to shut them off, by a slide to the aperture. Those that remain in the lower hive fly to their companions in the upper, and the contents of the lower hive may be taken in security. They stand the cold of a Russian winter. Wildman and Huish are the best English writers on their management; and, if preserved from year to year, they are very profitable, for their natural term of life is from four to seven years.

T. Nutt, of Moulton Chapel, Lincolnshire, has invented a very excellent and valuable bee-hive, by which the cruel practice of destroying the bees, to obtain their honey, is entirely obviated, and the produce considerably increased by the management of the hives and their inmates. The produce of a single cottage hive, under five years' management on this principle, is stated by Mr. Nutt to be—

| *Pounds.* | | | *Pounds.* |
|---|---|---|---|
| 36 | First swarm on the | 10th June, 1823 | |
| 127 | Union of the parent stock - - | 14th August, 1823 - - - - | 28 |
| 132 | Collection of honey - - - | 12th June, 1824 - - - - | 30 |
| 100 | - - - - - - - - - | 16th July, 1825 - - - - | 58 |
| 115 | - - - - - - - - - | 10th August, 1826 - - - - | 106 |
| 98 | - - - - - - - - - | 10th July, 1827 - - - - | 219 |
| 104 | - - - - - - - - - | 6th August, 1828 - - - - | 296 |
| 712 | For the bees' support during five years. | Contribution | 737 |
| 737 | Contribution. | | |
| 1449 | | | |

Not a bee was destroyed; one and the same domicile was stationary; and these interesting insects are now so tractable and domesticated by this humane management, that no danger is apprehended by the curious who may make their remarks and hourly observations at the back-window of the establishment.

The rearing and preserving of bees must, therefore, appear to be an object worthy of consideration. Suppose a person to commence with only two hives, which may cost *3l.* 10*s.* sterling; and preserving and keeping the bees, and allowing each hive, on an average, only to double its number annually, they would increase as follows, in a period of 10 years:—

| | | |
|---|---|---|
| 1st year | - - - | 2 hives |
| 2d ditto | - - - | 4 ditto |
| 3d ditto | - - - | 8 ditto |
| 4th ditto | - - - | 16 ditto |
| 5th ditto | - - - | 32 ditto |
| 6th ditto | - - - | 64 ditto |
| 7th ditto | - - - | 128 ditto |
| 8th ditto | - - - | 256 ditto |
| 9th ditto | - - - | 512 ditto |
| 10th ditto | - - - | 1024 ditto |

At this rate, two hives would produce 1024 swarms in the period of 10 years, which, at a very moderate calculation, would be worth 1*l.* 15*s.* sterling each; so that there would be a clear profit of 1792*l.* sterling, for a little attention to the rearing and proper management. It may be supposed, by the above estimate, that the seasons are favourable; but allowing 50 hives to fail, from various causes, there would still remain 1704*l.* 10*s.* sterling of clear profit. The years 1824 and 1825 were very favourable for bees: the latter was remarkably so. Almost every hive that year swarmed once, many of them twice, and a few even three times; when the store was collected, they weighed from 25 to 40 lbs. each hive.

It is estimated that Scotland could maintain as many bees as would, on an average, produce 4,000,000 pints of honey, and 1,000,000 lbs. of wax. Were this quantity tripled for England and Ireland, the produce would be 12,000,000 pints of honey and 3,000,000 lbs. of wax annually.

*Bees in Forests.*—It has been a custom in Livonia, from time immemorial, to make cavities in the trees of a forest for the purpose of receiving and rearing the swarms of bees. Some of the proprietors have hundreds and even thousands of bee-trees. Those which are chosen for this use are large oaks, firs, pines, alders, &c. It has been objected to this system, that it destroys the forests, and diminishes the quantity of building-wood: but it is not necessary to choose the finest trunks, and stunted trees are equally serviceable for this use, if they have sufficient size. A bee-tree is worth more than if sold for wood; the old hollow trees, which will serve for an age or two, spread seed around, and cause the production of young suckers, which would be obtained with difficulty by destroying the old trunks. The pure air of the higher regions agrees better with the bees than the air enclosed in hives, which receive the exhalations of the earth, and in which contagious diseases sometimes make great ravages. When garden-bees swarm, they are directed instinctively towards the woods, whilst the bees of the wood never swarm towards the gardens.

In America, black willow and red maple are the first trees that are visited by bees; and they are fond of the crocus, which is the earliest of American bulbous-roots. Blossoms of all kinds, excepting those of the red-clover and the honeysuckle, are excellent food for them; and they especially profit by the increased attention bestowed on the cultivation of the peach-tree. They not only drink the nectar and abstract the pollen of the flower, but appropriate the peach itself. Twenty or thirty bees will devour a peach in half an hour, or carry the juices to their cells. Strawberry blossoms, mignonette, wild and garden thyme, herbs of all kinds, apple, plum, cherry, and above all, raspberry-blossoms and white clover, are delicious food for them, and a thriving orchard and apiary fitly go together.

*Swarming of Bees.*—The hive is placed upon a weighing beam, about three feet eight inches long, with a board on the other end, on which stones of the weight of the hive are put. When the bees begin to cast, (an ordinary top swarm is between 4 lbs. and 5 lbs. weight,) and when the first pound's weight of bees have left the hive, the beam will turn back a little, the same way as a shopkeeper's scale does on the counter: but, before the scale rests, it forces out a trigger, like the pin of a mole-trap, which lets off a small iron wire to a bell in the house, and gives sufficient warning to the bee-mother to go and take care of the swarm.

*Bees, swarming of.*—T. A. Knight, Esq. describes the precaution taken by a swarm of bees, in reconnoitering the situation where they intend to establish their new colony, or swarm from the parent hive. The bees do not go out in a considerable body, but they succeed each other in going and returning, until the whole of the swarm have apparently made the survey, after which the whole body take their departure in a mass. If by any chance a large portion of a swarm take their departure without the queen bee, they never proceed to take up their ulterior quarters without her presence. Mr. Knight's observations tend to prove, that all the operations of a swarm of bees are dictated by previous concert, and the most systematic arrangement.

The best situation for bee-hives is a little to the west of the south; for the sun shining into the mouth of the hive too early, calls the bees abroad before the cold is exhaled from the flowers, and the juice turned into honey: but in this situation the sun reaches the front about 9 o'clock. The front should lean a little inwards, that the mouth of the hive may fit close to the mouth made in the boards, which should be 3 inches long in summer, and 1 in winter, and about one-fourth of an inch high.

*Bees' Wax.*—Have on the fire an open vessel of boiling water, and standing by the fire an open vessel of cold water; put the comb, close tied in a canvass-bag, into the boiling water, and repeatedly squeeze it down with a large wooden spoon. The wax will come through the bag, and swim on the surface of the water; skim it off, and put it in the vessel of cold water. By repeatedly squeezing the bag and skimming, every particle of wax will be obtained. When congealed on the cold water, it may be taken off, again melted, and cast into moulds. Both wax and honey may be bleached perfectly white by steam, or by exposure to a humid atmosphere; and in frosty weather the operation is rapid. It is by bleaching in frosty weather that the Jews bleach common honey to such a degree of whiteness.

The wax is believed to be a secretion from the rings of the abdomen of particular bees when well-fed. They secrete also a glutinous resin, called *propolis*, with which they stop all the crevices of the hive before they build the combs.

BEET, is a well-known valuable succulent root, cultivated in kitchen gardens, and growing wild in the south of Europe. There are two principal varieties, one of which is of a deep red or purple color, and the other is white, crossed with bands of red.

Red beet is principally used at table, in salad, boiled, and cut into slices, as a pickle, and sometimes stewed with onions; but, if eaten in great quantity, it is said to be injurious to the stomach. It may be taken out of the ground for use about the end of August, but it does not attain full perfection till October. When good, it is large, and of a deep red color, and, when boiled for three or four hours, is tender, sweet, and palatable.

It has lately been ascertained, that beet-roots may be substituted for malt, if deprived of the greater part of their juice by pressure, then dried, and treated in the same manner as the grain intended for brewing. The beer made from the beet has been found perfectly wholesome and palatable, and little inferior to that prepared from malt.

From white beet the French prepare sugar. For this purpose, the roots are boiled as soon as they are taken from the earth. When cold they are sliced, and the juice pressed out, and evaporated to the consistence of syrup. The sugar is then obtained from the syrup by crystallization. 110 lbs. weight of the roots yield $71\frac{1}{2}$ lbs. of juice, which, on further evaporation, afford more than $5\frac{1}{2}$ lbs. of brown sugar; and these, by a subsequent operation, produce 4 lbs. of well-grained white sugar.

The residuum, together with the syrup or molasses which remain, produce, after distillation, $3\frac{1}{2}$ quarts of rectified spirit, somewhat similar to rum.

The leaves of the beet, raised in richly-manured soil, yield also a considerable quantity of pure nitre. The French and other European nations still persevere in manufacturing beet sugar, and make great quantities of it, so as, in many places, to supersede the use of West India sugar, and its production has been wisely encouraged by bounties and prohibitions. It is the finest sugar that can be made, both to the eye and palate.

The manufacture of beet-root sugar in France has, in fact, advanced so far, that it presents all the intricacy and imposing developement of old establishments, carried on with considerable capital and expensive machinery.

The processes of rasping and pressing are performed in many cases by steam-engines and hydraulic-presses: and the boiling, concentrating, evaporating, and crystallizing processes are very generally carried on by the agency of steam.

Beet-root is in much more general cultivation on the continent, as a cattle-crop, than turnips. The beet-root is better adapted for their state of husbandry than the turnip. It admits of being taken up in October, and is pitted or stored for winter use, like potatoes. It is, bulk for bulk, a more substantial food than the turnip; and, in spring, it is food when the turnip has ceased to be so. There are many varieties of the beet-root cultivated for cattle crops. There is beet-root entirely red, and entirely yellow, and entirely white; and white with red streaks, white with red skin, white with yellow skin, &c. Of these varieties, the entirely white is preferred for sugar-making: not as containing a greater proportion of saccharine matter than the other varieties, but as yielding juice more free from coloring matter. Roots of a medium, or rather small size, not exceeding 2 lbs. weight, and which creak under the knife, and present a hard and almost shining fracture when broken, are the most productive in sugar.

The cultivation of beet-root, by the small proprietors of land, is a regular and common branch of husbandry, and sugar is not only made on large scales by the manufacturers, but by housewives of the farm-house, as a branch of domestic economy, requiring not more skill or trouble than cheese-making or brewing.

The beet-root sugar-makers on a large scale refine their sugars, and produce sugar which, for whiteness and beauty, is unequalled by the refined sugar from West India sugar. Bulk for bulk, however, the refined West India sugar is sweeter than the refined beet-root sugar; but, weight for weight, they are equally sweet. A lump of refined beet-root sugar of the first quality is lighter than a lump of equal dimensions of refined West India sugar, probably because it is more pure and free from extraneous matter; but a pound weight of beet-root sugar differs from a pound weight of West India sugar only in our receiving more of these lumps in our pound weight. It is, for domestic use, even more economical.

From 5 to 7 *per cent.* of raw or Musovado sugar appears to be the usual produce from a given weight of beet-roots. From a given weight of this raw sugar, 40 per cent. of the finest white refined sugar, with 15 per cent. of inferior refined sugar, are the quantities produced; making about 2 lbs. 4-5ths weight of the finest white refined sugar from every 100 lbs. of raw beet-roots. The pulp from which the juice is extracted, and the other residue of the manufacture, are used for feeding cattle. According to M. Chaptal, the value of the molasses, pulp, &c. is one-fourth of the expense of the manufacture. It is a promising feature of the manufacture, that it is linked with the ordinary business of husbandry,—that it operates upon a known root cultivated for feeding cattle, and that the farmer, whether he raises beet-root for feeding cattle, or for sale to the sugar-baker, is cultivating a green crop, which, in his ordinary rotation of crops, he would at any rate raise on a part of his farm.

The beet best for sugar is white and yellow, and that which is red outside and white within. It thrives best in mixed soils. In France the juice is expressed with Burette's or Odobel's rasps for potatoes and beet. Tin-rasps with holes answer in a small way, but the above rasps are cylinders armed with saws and turned by machinery. The pulp is then put in bags, and pressed, yielding in juice 60 or 75 per cent. of the weight of the raw root. It produces crystals of sugar and bad-flavoured molasses, from which, however, good rectified spirits are produced.

*Another Account.*—After the roots are reduced to pulp by rasps, it is placed in bags and submitted to presses which yield from 65 to 80 per cent. of juice from the pulp. This marks from 5° to 9° of Beaumé.

It contains sugar in crystals and molasses; also water, leaven, &c. It may at once be set to ferment with its own leaven, and it works well.

An hectare (2·47 acres) will yield 80,000 or 100,000 lbs. of beet-root, costing per 1,000 lbs. about 5 or 6 francs; and 1000 lbs. yield 700 lbs. of juice of 9° gravity, which, diluted to 5°, yield 7½ gallons of fine spirit at 19°, or 0·941 sp. gr.

There is even more advantage from first separating the sugar, but the molasses is impregnated with much saltpetre, though it yields more spirit than the molasses of the sugar-cane, and the flavour is very pleasant. Properly treated by fermenting, 22 gallons of syrup yield 16 or 17 gallons of spirit at 19°. Some add grain to the fermenting solution. Dombasle and other distillers get 22 of spirit from 22 of the beet-root molasses.

White or yellow beet-root, or the white inside with red skins, are the best for sugar, or for distillation. It is sown in April, and dug at Michaelmas. As soon as possible they are necked and deposited in cellars or pits, covered with mould to keep out frost.

The stem and leaves of the common beet, when dried and burned, yield ashes so rich in potass, that it surpasses many of the commercial varieties.

**BELLADONA**, or deadly night-shade, is a poisonous plant, but in doses of 1 to 10 grains is found beneficial in many complicated disorders. It yields by analysis an alkaline principle, called *Atropia.* The poison of its leaves or berries has an antidote in lime-water, and in emetics of sulphate of zinc or copper, followed by purges and acids.

**BELL-METAL**, is copper united with large proportions of tin. The sonorous property increases as the proportion of tin is increased, within certain limits; provided the alloy possesses sufficient strength not to be fractured. But as the brittleness increases with the increased proportion of tin, not more than 1 part of tin is added to 3 parts of coppeer, to compose the most sonorous metal that is manufactured, namely, *bell-metal.*

The proportion of tin varies in bell-metal from one-third to one-fifth of the weight of copper, according to the sound required, the size of the bell, and the impulse to be given. But the alloy just mentioned is too brittle to be beat out into a plate for making a trumpet; and an ancient lituus, made of hammered metal, being found to contain only about 1 part of tin and 7½ parts of copper. Darcet has discovered that bell-metal, formed in the proportion of

7·83 parts copper, united with 2·2 of tin, is nearly as brittle as glass, when cast in a thin plate, or gong; yet, if heated to a *cherry red, and plunged into cold water*, being held between two plates of iron, so that the plate may not bend, it becomes malleable. He has therefore manufactured gongs, cymbals, and tomtoms, in this proportion. It appears also that sixty-four ounces of copper, with three of tin, forms a pale metal, ringing very like sterling silver.

BELLOWS, is a machine so formed as to receive and expel air by turns, by the enlargement and contraction of the capacity. The first deviation from the ancient, and still common form of the bellows, was made by the Germans, about 100 years ago, and the forms at present are very various, as many attempts have been made for the improvement of this highly-important machine, which becomes necessary where-ever powerful flame is required. As mining is carried on extensively in Germany, and great heat is required in smelting ores and working metals, many new kinds of bellows have been invented. M. Von. Baader, Munich, makes one which consists of an empty box, that moves up and down in another, partially filled with water. Between the bottom of the empty box and surface of the water is a space filled with air, which is driven out by the descent of the enclosed box. Bellows of very great power are generally called *blowing-machines*, and one of the largest is that recently erected at the smithery in the dock-yard, Woolwich. It supplies air for 40 forge fires, amongst which are several for forging anchors, iron knees, and heavy pieces of smithery. The common Chinese bellows consist of a box of wood about 2 ft. long, and 1 ft. square, in which a thick square piece of board, which exactly fits the internal cavity of the box, is pushed backwards and forwards. In the bottom of the box, at each end, there is a small conical or plug valve to admit the air, and valves above to discharge it.

The bellows used to force air into mines are called Hessian Bellows.

The great blasting-bellows, in many iron-works, are wrought by engines of 100-horse power, and their roar may be heard for five or six miles.

BENNET, or Avens, has roots scented like cloves, sudorific, tonic, stomachic, febrifuge. They may be substituted for bark, and when young they pleasantly flavour ale, and prevent its becoming sour.

BENZOIC ACID, is the sublimation of benzoin. The usual method of obtaining this acid is to put a quantity of benzoin, coarsely powdered, into an earthen pot, to cover the mouth of the pot with a cornet of brown paper, and then to apply a very moderate heat. The benzoic acid is sublimed, and attaches itself to the paper. Some use a large house, as it is called, made of pasteboard and laths, and lined with blotting paper, in loose sheets, every time it is used. Some empyreumatic oil is generally carried up, which soils and injures the acid sublimed.

Scheele published a different method, which is often used. A gallon of water is poured upon 4 lbs. of unslaked lime: and after the ebullition is over, 9 more gallons of water are added. Then 12 lbs. of finely-pounded benzoin are put into a tinned copper boiler, and 6 lbs. of the above milk of lime are first put upon it. They are mixed well together, and thus successively the rest of the mixture of lime and water is added. If it were poured in all at once, the benzoin, instead of mixing with it, would grow lumpy. This mixture ought to be boiled over a gentle fire for half an hour, and constantly stirred, then suffered to stand quiet for an hour, in order that it may settle. The supernatant limpid liquor is poured off into a stone-ware vessel. Upon the remainder in the pan 10 more gallons of water are poured; they are boiled together for half an hour, then taken from the fire, and left to settle. The supernatant liquor is added to the former; and upon the residuum some more water is poured; it is boiled as aforesaid, and the same process repeated once more. All the residuums are at last put upon a filtre, and hot-water several times poured upon them. All these clear yellow liquors and decoctions are mixed together, and boiled down to 2½ gallons, which are then to be strained into another glass vessel. After they are grown cold, muriatic acid is to be added, and constantly stirred, till there be no farther precipitation, or till the liquid tastes a little sourish. The benzoic acid, which was before held in solution by the lime, falls down in the form of a fine powder.

Benzoic acid is also obtainable in large quantities from the urine of grass-eating animals, as horses, or cows; by merely boiling it down to a small quantity, and then adding muriatic acid, the benzoic acid separates and falls to the bottom of the liquid. It may also be obtained by adding muriatic acid to the water that drains from dunghills. The acid thus prepared has not the fine scent of that procured from benzoin, but this scent may be given it by subliming it with three-quarters of an oz. of benzoin to the lb.

*Benzoic acid* may be obtained from the resin benzoin, or from tonca bean, vanello, cinnamon, cloves, and urine.

The compound tincture of benzoin

composes Friar's balsam, Wade's drops, Jesuit's drops, balsam of honey, and essence of coltsfoot, the last being an equal part of balsam of tolu, with spirits of wine. Benzoin also is the basis of the cosmetic virgin's milk, and of fumigating pastiles.

BERE or BEAR, is a species of barley, grown after a potatoe crop in Scotland and Ireland, and largely consumed in the distillation of whiskey.

BERGAMOT, a fragrant fruit, whose oil is much used in perfumery, and a result of the citron grafted on the bergamot pear.

BERYL, is a coloured variety of emerald, and sometimes light-green, pale-blue, or yellow. They are found in cavities of granite in many countries, especially in Peru and Brazil. They are often large, coarse, and dull, but the late Emperor of Brazil had one of the finest of sea-green, which weighed 225 troy oz. Different chemists have found in emeralds and beryls nearly the same components, two-thirds silex, one-sixth alumina, and one-eighth glucine, with smaller fractions of lime, crome, and iron.

BETEL, is the leaf of a climbing East Indian plant (piper-betel,) which belongs to the same tribe as pepper, and, in shape and appearance, is like ivy, but more tender and full of juice. There is an incredible consumption of betel throughout the East. The inhabitants chew it almost incessantly, and in such quantity that their lips become quite red, and their teeth black—a color greatly preferred by them to whiteness. They carry it, in little white boxes, about their persons, and present it to each other, by way of compliment and civility, in the same manner as Europeans do snuff. This is done by the women as well as by the men; and it would be considered an offence, if those to whom it is offered should refuse to accept and chew it. The leaves are sometimes used alone, but much more commonly when covered with a kind of lime made of sea-shell, and wrapped round slices of the areca-nut, the fruit of the areca-palm, of the size of a small egg, and resembling a nutmeg deprived of its husk.

BEZOAR, consists of the *monkey bezoar*, from the stomach of an unknown species of monkey. It is bright green, with a fine lustre, and in the highest esteem as a cordial.—The *oriental bezoar*, from the stomach of the capra gazella; dark green, or olive; marking a green line upon paper.—*Snake stone*, from the stomach of the capra ægragus, applied to places bitten by snakes.—*Occidental bezoar*, from the antelope oryx.—*Hog bezoar*, from the stomach of the wild hog.—*Piedra del porco*, from the gall-bladder of the porcupine.—*Camel bezoar*, from the gall-bladder; used as a yellow pigment.—*Buffalo bezoar*, from the gall-bladder.—*Gallstone*, *calculus cysticus bovinus*, from the gall-bladder of cattle in winter, when fed upon dry food and used as a yellow pigment.

BICE, is a blue, well ground from smalts, or *lapis armenius*. It becomes green with orpiment.

BIDDERY WARE, is of a black colour, and it never fades. It is made by adding 24 lbs. of tin to 1 lb. of copper in a melted state. The mixed metal is, of course, in this stage of a white colour, and is made into any required form by the usual method used in casting small articles. The article being cast, and, if necessary, dressed, it is then scraped with a knife, and coloured of a lasting black colour, with equal parts of sal ammoniac in powder, and of the reddish saltpetre earth found in the neighbourhood of Biddery, which are made into a paste with a little water, and rubbed on the metal, and it instantaneously assumes a lasting black colour. The fine sable hue may be always restored, on being merely rubbed with a little oil or butter. In some other parts of India, they melt together 16 ozs. of copper, 4 ozs. of lead, and 2 ozs. of tin, and having poured out this metal into ingots, they then melt 3 ozs. of this mixed metal along with 16 ozs. of spelter, and cast their articles in the usual way. As the saltpetre-earth contains not only saltpetre but also common salt, so in places where it cannot be procured, the articles may be washed with a solution of 1 oz. of sal ammoniac, a quarter oz. of saltpetre, another quarter oz. of common salt, and the fifth part of an oz. of blue vitriol.

BILE, is a bitter, yellowish liquid, separated from the venous, or returning blood in the *vena portæ*, which passes into, and ramifies in the liver. It is the evident product of the union of the blood with the nitrogen of the atmosphere at the skin, and some have considered it as a kind of soap, used as such by scourers. It consists of water, its own peculiar *picromel*, resin and various alkalies. It is decomposed by all acids. Berzelius reduces 1000 parts to 908 water, 80 picromel, 3 albumen, and 1 of soda, salt, lime, &c. It mixes with the food in the duodenum, and assists in the formation of chyle, before its entrance into the *vena cava*, and in forming the fæces in the bowels.

BILLS OF EXCHANGE, and Promissory Notes, are negociable commercial engagements, by which credit and payment are facilitated in trade. When credit is good, and floating capital is not absorbed by government securities, in

Exchequer Bills, they double the means of trade, by enabling a vendor to give credit on a bill of the buyer, which he, the vendor, can discount in the money market, at the current rate of interest, which his profits enable him to pay; and often, therefore, it is also used as a means of raising capital to carry on useful and profitable enterprises. Before the panic of December, 1825, the bills and notes in circulation amounted to about 500 millions, of which it is estimated 300 millions were bottomed on purchases and sales, and 200 millions were means of raising capital by which hundreds of important manufactories and concerns were carried on. The panic destroyed credit, and the government measures concurred with the panic, and hence the general ruin of commercial establishments.

Bills of exchange are credit in circulation, and activity, and in an efficient manner add to the currency. A book debt is a credit, and adds to the capital of the debtor, but a bill of exchange accepted by the debtor in liquidation of the debt, and issued by the drawer, becomes till due part of the active currency. Of course, the amounts are as transactions, and their credit as that of the drawer, acceptor, and indorsers.

A bill of exchange is properly a bill drawn in one country upon another, or a bill drawn by one upon another and accepted; a promissory note is an engagement of the drawer to pay to another, or his indorsement. Their increase kept pace with the monetary system of the government, and were the means which enabled the people to pay 70 or 80 millions of taxes, instead of 2 millions. Their forcible withdrawal, and the continuance of 50 millions of taxes, is the chief cause of the general ruin of our industry.

All the credit transactions of a country might appear in bills of exchange, but in retail dealings the amounts are growing, and as they fix a day of payment a consumer of goods by retail refuses to be so bound. They are more usual among manufacturers and merchants, or among wholesale and retail dealers. They serve to define the credit, and fix a period of payment. As negotiable instruments they are discountable, but their use in this respect depends on the quantity of legal currency, and on the credit and facilities of the parties. Owing to the want of regulation, the transaction on which they are apparently founded is frequently not real, and they may be created merely to raise money by discount, and then they are accommodation bills, which too commonly end in confusion, and in the ruin of the parties. These absorb the currency without profitable transactions, and the exchequer bills of government are of this description. All such transactions might be regulated, by obliging the parties drawing the instrument to express the nature of the consideration, and to refer to the book of account in which it appeared. Many bills are, however, drawn avowedly as security to a lender of money, in lieu of bonds, when the lender demands two securities.

BINNACLE. The binnacle which contains the compass is a box upon the deck, with a partition, dividing it into two chambers, one for a lamp or candle, and the other for the compass-box; the partition having a pane of glass, and the front of the division, where the compass is kept, has also a window to see into it. The compass-box is generally made of wood, and square, containing within it a circular brass box, suspended on gimbals, and in this is the compass card. Its points are read against a mark, usually made by a pencil, within-side the brass box, and called *Lubbers' Mark.* A line drawn from this to the centre of the compass card should, in all cases, be exactly parallel to the line of the ship's keel, otherwise her course by the compass will never be correct; the manner in which the compass-box is fitted into the binnacle renders this very uncertain, for the square box being smaller than the inside of the binnacle, wedges are driven in all round to make it fast; but there is nothing to make it certainly parallel to the ship's keel. The binnacle is frequently made with three divisions instead of two, then a compass is placed in each side, and the light in the division between them; but, unless the binnacle is very large, there is an objection to placing two needles so near together, as they are liable to act upon each other. The light is very imperfectly thrown upon the compass card in the common way, and may also be seen at a distance from the ship.

But it being found that the iron in ships affects the needle according to the direction in which she is sailing, a metal plate of iron has latterly been placed vertically between the compass and the ship, so as to neutralize and destroy this effect and its variations.

Preston has lately taken out a patent, to correct the baffling vibration of the card in ships' compasses.

BIRCH, a hardy tree, which thrives in elevations of 1500 feet, in any poor soil. Its hard wood is highly useful; it makes good wine, and its bark is a valuable and indestructable tannin of an unctuous character, which no insect will attack.

BIRD-LIME. Boil missletoe-berries in water till they break, pound in a mortar, and wash away the branny refuse. The *holly bird-lime* is made from the bark, stripped in June or July, boiled in water six or eight hours, until tender; the water separated, the bark is laid in layers with fern, and left to ferment till it forms a mucilage, which is pounded in a mortar into a mass, and in the hands, in running water, all the refuse is worked out; the bird-lime is then put into an earthen vessel, and left some days to purge itself.

BIRDS' NEST. The *hirundo esculenta*, a species of swallow, the nests of which are used as an article of luxury among the Chinese. It is found in the Indian seas, and they are particularly abundant in Sumatra, especially near the south end of the island. The nest has the shape of a common swallow's nest, and is about the size of a goose's egg. It is found in caves, particularly on the sea-shore, and has the appearance of imperfectly concocted isinglass. The manner in which the swallows procure this substance is not ascertained. The most probable suppositions are, that it is the spawn of fish gathered by the bird, or a secretion elaborated in the body of the animal. The Chinese collect the nests, and sell them, since when dissolved in broths, &c. they make a delicious jelly. The finest are those obtained before the nest has been contaminated by the young birds. The pure white are scarce and valuable. The inferior ones are the dark coloured, streaked with blood, or mixed with feathers. Some of the caverns, in which they are built, are difficult of access, and dangerous to climb.

BISCUIT, is made chiefly for consumption at sea, and for this purpose is baked twice, and for long voyages four times.

BISCUIT JELLY, is made by boiling 4 ozs. of fine biscuits in 2 quarts of water to half; then strain and boil to a pint. Afterwards add sugar, port, and cinnamon-water. It is excellent in diarrhœa, dysentery and delicate digestion.

BISMUTH, is a metal called *tin glass*. It is found both pure, and mineralized by sulphur, oxygen, and arsenic.—Native bismuth occurs in the veins of primitive mountains, and is accompanied by ores of lead, silver, and sometimes of cobalt and nickel. It exists in reticulated, lamellar, or amorphous masses; is soft, and of a white colour, occasionally tinged with red. Sp. gr. 9.

To procure the metal, the ore requires merely to be reduced to convenient fragments, and heated in furnaces, when the bismuth separates from the earthy matter in which it is engaged, and flows out into cast-iron moulds prepared for its reception.

Bismuth, when pure, has a reddish-white colour, is harder than lead, and is easily broken under the hammer, by which it may even be reduced to powder. It melts at 470° or 480°, and crystallizes, on cooling, with great regularity, in the form of cubes. When kept in a state of fusion, at a moderate heat, it is covered with an oxyde of a greenish gray, or brown colour; at a higher temperature, it enters into a feeble combustion, forming a yellow powder, called *flowers of bismuth*.

When pure, no metal is so easily obtained in the form of crystals, which are small cubes grouped together. The bismuth is to be melted in a covered crucible, and a good heat given to get rid of any arsenic it may contain. It is then to be poured out into a warmed black melting pot, having a hole in its side closely stopped with a wooden peg. As soon as the bismuth has set at top, the peg is to be withdrawn, that the liquid part of the metal may run out. On turning out the solid crust of metal, it will generally be found finely crystallized on its under surface. Bismuth, like cast iron, expands as it sets, and even retains this property when mixed with other metals.

Bismuth is a metal very easily melted, and the only ores smelted want merely the application of heat to run the metal from the stone in which it is enveloped. Hence bismuth is sometimes obtained by merely lighting a wood fire upon a hearth of rammed clay, and throwing the ore into the fire. When the fire goes out, the bismuth is separated from the ashes by washing them in water, re-melted in an iron pot, and poured into ingot moulds. Bismuth is also obtained by the same apparatus of double pots, as crude antimony. The greatest part of the bismuth used in Europe is obtained at Schneeberg, in Saxony.

It combines, by fusion, with a great number of metals, communicating to them brittleness and fusibility. The mixture produced by melting together 8 ozs. bismuth, 5 ozs. lead, and 3 ozs. tin, fuses at 202°. From it are made toy spoons, which melt on being employed to stir very hot tea. A still more fusible compound was invented by Dalton, composed of 3 parts tin, 5 lead, and $10\frac{1}{2}$ bismuth, which melts at 197°. The addition of a little mercury renders it even more fusible, and fits it to be used as a coating to the inside of glass globes.

An alloy of equal parts of tin and bismuth melts at 280°; a less proportion of bismuth adds to the hardness of tin, and hence its use in the formation of *pewter*.

Equal parts of tin, bismuth, and mercury form the *mosaic gold*, used for various ornamental purposes.

One part of bismuth, with 5 of lead, and 3 of tin, form *plumbers' solder*, a compound of great importance in the arts.

Bismuth is also used by *letter-founders* in their best type-metal, to obtain a sharp and clear face for their letters.

Bismuth combines with sulphur, and forms a bluish-gray sulphuret, having a metallic lustre. The same compound is found native in small quantity, and is called, in mineralogy, *bismuth glance*.

Nitric acid dissolves bismuth, and on the addition of water a white substance, called *magestery of bismuth*, is precipitated, which consists of a hydrated oxyde, united to a small proportion of nitric acid. This precipitation, by the addition of water, being a peculiarity of bismuth, serves as an excellent criterion of this metal. The magestery of bismuth, from its whiteness, is sometimes employed to improve the complexion; as well as in *pearl powder*, a similar preparation, differing only by the mixture of a little muriatic acid with the nitric acid in effecting the solution of the bismuth.

The chloride of bismuth, formerly termed *butter of bismuth*, is formed by pouring bismuth, in fine powder, into chlorine gas, or by depriving the muriate of bismuth of its water of crystallization by heat.

*To make sub-nitrate of bismuth.* Add 7 parts of powdered bismuth gradually to 20 parts of dilute nitric acid, and dissolve by heat. Wash with water, and dry on bibulous paper with gradual heat. In doses of 1 to 12 grains, it is beneficial in spasms, affections of the heart, and epilepsy.

BISON; a species of ox found only in North America, peculiarly distinguished by a great hump or projection over its fore shoulders, and by the length and fineness of its woolly hair. The hump is oblong, diminishing in height posteriorly, and gives a considerable obliquity to the outline of the back. The hair over the head, neck, and fore part of the body, is long and shaggy, forming a beard beneath the lower jaw, and descending below the knee in a tuft. The hair on the summit of the head rises in a dense mass, nearly to the tips of the horns, and, directly on the front, is curled and matted.

BISTRE, is made by boiling 1 lb. of the soot of beech in half a gallon of water for half an hour. After which settle, pour off, and evaporate. The residuum with gum water forms cakes of bistre, for drawing and washing drawings.

BITES OF ADDERS, are cured by olive-oil, or by ointment made of dragon's blood, barley-meal, and white of egg.

BITE OF SERPENTS.—The best remedy is a bottle of Madeira wine, drank at two doses, with only a few minutes' interval; or an equally large dose of any strong spirituous, or fermented liquor; or camphor and ammonia with Cayenne pepper. Ligatures should also be applied above the bites, or cupping glasses used over them. But repeated suction with the mouth is best. Inoculation with the juice of *rejuco*, or *Prenanthes serpentaria*, renders persons insensible to this poison.

BITTER PRINCIPLE, as in bile, quassia, &c. believed to be a compound of nitric acid and unctuous substance.

BITTERN, is the mother water of crystallized sea-water, and bitter, from containing sulphate and muriate of magnesia.

BITTERS. Gentian root ½ oz., Peruvian bark 1 oz., orange-peel 2 drs., cinnamon 1 dr.; for two bottles of white wine.

2. Gentian root 2 ozs., orange-peel 1 oz., lesser cardamoms ½ oz.; for a quart of brandy.

3. Gentian and orange-peel, each 2 drs., lemon-peel ½ oz.; for a pint and a half of boiling water.

BITTER BALLS, *(for brewers.)* Mix 8 lbs. of gentian-root powder with 4 lbs. of extract of gentian, and 6 lbs. of treacle.

*Other bitters for brewers.* Equal quantities of extracts of coculus Indicus and quassia, and equal weights of calcined sulphate of iron, and of Spanish liquorice.

BITTER TINCTURE. In two pints of alcohol infuse ½ oz. of lesser cardamom seeds, 1 oz. of orange-peel, and 2 ozs. of gentian root. *Or*, 1 lb. of gentian, 8 ozs. of orange-peel, 1 lb. of grains of paradise, 2 drs. of cochineal, 4 pints of raisin wine, and 12 pints of alcohol.—*Gray.*

BITUMEN, under various names contains the materials of a gas, or vapour, which, when suitably heated, becomes flame, or light. It consists of carbon and hydrogen, so combined as to produce that effect. It is *fluid* as naphtha and petroleum; *semi-fluid* as tar; *solid* as alphaltum, caoutchouc, resin, or coal. The first state is naphtha, and is a natural product of volcanic districts, and the air converts it into petroleum, but by distillation it returns to naphtha. With alkalies they form soaps, and with acids resins. In medicine they are used for asthma, tape-worms, chilblains, and paralysis.

It is found in an elastic state at Castleton, earthy at Trinidad, and slaggy at Matlock, in Albania, &c.

BLACK.—The absence of colour; and there are few substances which transfer it alone to other bodies. The juice of the cashoo-nut, and that of the toxicodendron, are the best.—*See* DYEING.

BLACKS, are, *Frankfort*, either an earth, or made from the dregs of wine, burnt and ground with bones or fruit-stones. *Ivory*, made of burnt bones, ground with water or oil. *Spanish*, or burnt cork. *Harts*, the residuum of distillations of hartshorn levigated. *Lamp*, made from the smoke of turpentine, &c. passed into a chamber and the soot caught in woollen cloths.

*Frankfort Black*, is made of the lees of wine, or argol, well washed and ground with water, and is used to make printers' ink.

Black from cork, burnt in close vessels, is used as a colour in painting.

*Wheat Black*, made from wheat, burned to a coal, is superior to lamp-black and equal to ivory-black; dries well and hard, in 8 hours, with boiled oil only.

*Ivory Black*, or *Cologne Black*, is made from ivory shavings, or dust, heated in covered iron pots. It is used as a dentifrice and a paint. With white lead it forms a pearl-grey colour.

*Bone Black*, or *Animal Charcoal*, is the residuum left after the distillation of bone, and used for making blacking for leather, for moulding delicate founders' work, for clarifying liquors, and for abstracting the lime used in making sugar from the syrup.

*Russian Lamp Black*, is made by burning the chips of resinous deals, made from old fir-trees, in tents, to the inside of which it adheres. Mixed with linseed-oil, it is apt to take fire by itself. It is used as a paint.—*Burnt Lamp Black*, heated in a covered iron pot, to get rid of its greasiness, is used as a water-colour.

*Lamp Black* is made from distilled oil of bones, burnt in lamps, with a long smoking wick. It does not take fire with drying oils.

BLACK CHALK, is a native mineral.—*Black Jack*, is blende.—*Black Lead*, is plumbago.—*Black Wadd*, is a manganese ore.—*See Col.* 245.

BLACK CLOTH.—As black is a colour in such general wear, and as there is a very great difference in this colour, according to the process made use of in dyeing it, it is useful to know how to distinguish permanent genuine colours, dyed in the wool, from false or spurious ones dyed in the piece—the former having received a ground or preparation of indigo blue, which is a fast and permanent dye, and can alone insure a sound colour—the latter, or piece-dyed colour, being almost entirely composed of logwood, combined with the sulphates of iron and copper, and is a false and fugitive stain upon the cloth.

As a test, put about a tea-spoonful of oxalic acid into a small phial, and add as much water as will dissolve it; shake the mixture till the chrystals disappear; then moisten the cork three or four times with the acid solution, and press it smartly upon the cloth to be examined. In a few minutes a spot will appear upon the part the cork has pressed, which, if indigo has been used as a base or ground to the colour, will be of a greenish olive shade; but if no indigo has been employed, and the colour is composed wholly of logwood, and the sulphates of iron and copper, the spot will change to a dusky orange, or fawn colour; and a black so dyed will fade on a few weeks' exposure to the sun and air, and turn to a dingy slate-colour. The wool dyed black, upon an indigo ground of proper depth, improves by wear and exposure to oxygen, and preserves a good full shade till the cloth is entirely worn out.

BLACK DRAUGHT.—Mix 5 oz. of the compound infusion of senna, 1 oz. of cinnamon-water, 4 drs. of manna, and 6 drs. of Epsom salts. To be taken in the morning, after calomel, or at any time.

BLACK DROP, *Braithwaite's Genuine*. In 3 pints of good crab verjuice boil gently, two hours, 8 oz. of sliced opium, $1\frac{1}{2}$ oz. of nutmegs, and 2 drs. of saffron; add 4 oz. of sugar, and, when cool, 2 table spoonfuls of yeast, and keep moderately aired eight weeks; then expose to the atmosphere till it is a syrup. Decant, and filter into small phials, in which is a little sugar. One drop is equally useful, with four of laudanum, and does not much affect the head.

BLACK FLUX, is the strong alkali produced by exposing cream of tartar, or crystals of wine-casks, to a red heat, till its volatile parts are driven off. It is used when oxygen is to be separated from any body with which it is in intimate connection, and for this purpose potassium is often employed as an alkaline exaltation of black flux.—*Or*,

Black flux is made by burning in a crucible two super-tartrate of potass with one of nitrate of potass.

BLACKING, for shoes, is commonly made of lamp-black and linseed-oil; or lamp-black, water, sugar, and gum, or the white of an egg; or lamp-black, sour beer, oil, molasses, and some sulphate of iron. *Or*, take of plaster of Paris, ground and sifted, 2 lbs. 4 oz.; lamp-black about 9 oz.; barley malt, as used by brewers, 18 oz.; olive-oil, 1 oz. Steep the malt in water almost boiling hot, till the soluble portions are well extracted. Put the solution into a basin, stir into it the plaster and lamp-black, and evaporate to the consistency of paste; then add the oil, the quantity of which may be increased by degrees.

To the mixture may be added a few drops of oil of lemon or lavender. If ground plaster of Paris cannot be procured, its place may be supplied with potter's clay. This is the cheapest and finest blacking; it spreads evenly, and dries and shines quickly on the leather by a slight friction of the brush.—*Or*, take of ivory-black 9 lbs. lamp-black 4 oz. treacle 9 lbs. olive-oil 12 oz. gum arabic 4 oz. green copperas 6 oz. and common vinegar 4 galls. Dissolve the gum arabic in 4 oz. of water, and mix all the articles with it in an open vessel, and when well blended, stir in, gradually, 8 oz. of *sulph. acid.* The composition, after standing two days, during which time it should be well stirred up twice a day, will be fit for use. —*Or*, macerate 1 lb. of malt in boiling water completely; add 2¼ lbs. of plaster of Paris and 7 oz. of lamp-black; evaporate to paste-like substance, and mix and stir with 18 oz. of olive-oil.

Blacking Balls.—Mix 1 oz. each of bees' wax, and lard, ivory-black, and lamp-black, and brown sugar; of each 8 oz. in 4 oz. of double glue-size.

*Or*, in 8 oz. of water dissolve 2 oz. of sugar-candy, 1 oz. of gum dragon, and 8 oz. of ivory-black.

BLACK-LEAD, the vulgar name of plumbago, used in making pencils.

BLACKNESS, always arises from such a subdivision of the atoms of the surfaces of bodies as enables the light to penetrate among them and be absorbed or lost. A perfect black surface affords, therefore, a test of the quantity of heat which the velocity of atoms of light can generate in a given time. The velocity is imparted to the body, and hence the heat. The atoms are not reflected, and hence the want of colour, and the negation of blackness. Separation of atoms, by the intense action of heat into pure carbon is the best means of conferring blackness. Trituration does not reach those primary atoms whose re-actions alone affect light.

Black Reviver.—Take 2 pints of vinegar, and infuse 1 oz. of iron-filings, of sulphate of iron, of copperas, and of ground logwood, with 3 oz. of bruised galls, for rusty garments.

Black Wadd, the Derbyshire name for the ore of manganese, as sold to glass-makers and the potteries. It takes fire on being dried and kneaded with a fourth of its weight of linseed-oil. The compound heats gradually, and then bursts into flame. Oils and nitric acid do the same. The oxygen of the manganese and nitric acid combine with the hydrogen of the oil, and generate heat. This generates vapour from the carbon of the one, and increased heat of the vapour renders it lambent, like all other red-hot smoke.

BLAINE'S DISTEMPER POWDER, is sulphuret of tin.

BLANKETS; a coarse though highly useful article of domestic life. In the Author's tour, in 1829, he visited the great blanket manufactory of Halliley, Brooke, and Halliley, of Dewsbury, and he extracts the following from his yet unpublished Notes, written in the hospitable mansion of Mr. Halliley:—"As blankets are bulky articles, consume much material, and go through nearly as many processes as cloth, so the space occupied by the machinery is extensive. The wool used is British, or the long staple of foreign wool, chiefly brought from the Don. British would suit the fabric, but the other is cheaper, even after all expences and charges are paid.

Blanket-wool is a middle kind, between the short fine and the long coarse, and that of the British fleece may be divided between that on the back and sides, for combing and worsted purposes, and that on the belly parts for this and other coarse woollen goods.

The wool being *devilled*, a sit is called, or cleared and opened, and is oiled to the weight of one-eighth. It is then scribbled, carded, and spun into warp and weft, by *billies* and *mules*. Afterwards it is wove in widths, varying from 4 quarters to 20 quarters; and in lengths of webs from 60 to 100 yards, of course, including many separate blankets. The pieces are then milled, and cleaned in fulling stocks, where, like cloth, they are beat with ponderous wooden hammers for some hours, reducing them a sixth, or a half on superfine. The most important operation is that of raising or conferring on blankets their rough pile. This is effected by rollers covered with brass pins, and over these one side of the blanket is passed twice, and the other side three times. The ornamental corners are then affixed by women with the needle, and the blanket being carded, is ready for sale.

All the machinery in a blanket manufactory are larger and more effective to the eye than those used in cloth-making, besides being more numerous and occupying a larger space. The steam-engine for such heavy work is, in this concern, a 60-horse power.

In viewing these establishments, I had no repining in regard to the condition of the operatives, of whom there are nearly 800. Nothing is crowded, the work is light, and the people appeared to be cheerful and healthy. I saw blankets of the best make, 14 quarters wide by 15 quarters long, adapted to royal and imperial state-beds.

Coals are cheaper at Dewsbury than in any place in Yorkshire. Through the entire coal districts they are 5*s*. 6*d*. 6*s*. or 7*s*. per ton, but at Dewsbury they cost only 4*s*. There are four or five beds, three of which are worked, and the lower one is a yard thick, extending eight or ten miles around. Gas-lights, therefore, cost but a trifle, and the 1000 burners used in this blanket manufactory consume but four tons, or 16*s*. worth, a week; while the coke is worth as much as the coal, being free from sulphur; so that the entire cost is the wages of the superintendent, or 24*s*.; *i. e.* about a farthing per burner per week. The system is, to keep the four retorts at a cherry-red heat, from the commencement of the gas-lighting season till its end; and it appears they are cast metal, four inches thick, and, therefore, now as perfect as when set seven years before. For a fifth of the light the same establishment used to consume the sixteenth of a ton of oil per night, which, at one time, was 5*l*.'s worth. I was informed that nearly 3000 pair of blankets per week are made in this manufactory, and that it consumes about 5000 packs of 240 lbs. of wool per annum."

BLASTING, is the application of gunpowder in the disseveration of rocks in mining, tunnelling, canal-digging, road-making, &c. A hole is bored in stone, according with the direction of the strata, the hardness of the rock, &c. from half an inch to two inches in diameter, and from one to six or seven feet deep. It is made with a jumper, turned and struck with a hammer, and then half filled with powder. A copper rod is inserted in the powder, and the whole filled with earth or sand, as wadding, to keep out the atmospheric air. The copper rod being withdrawn, the hole left by it is then filled with straw, filled with powder, and a lighted match of paper, dipped in salt-petre, is applied. The explosion soon follows, and if the rock is not covered with furze or underwood it is driven about in a dangerous manner.

Under water the charge is inserted in a tin cartridge, and the priming lighted through a tube from the top of the water. Such used to be the practice, but HANCOCK's unextinguishable fuse supercedes the old practices.

Freezing water splits rocks, and so does the gas evolved from slacked lime.

Trees are sometimes blasted with powder, by an augur-hole bored in the centre, especially when intended only for fire-wood.

The quantity of powder necessary to raise different kinds of earth, masonry, and rock, established from experiment by Mouzé, is as under:—

| | To raise one cubic foot. | | To raise six cubic feet. | | |
|---|---|---|---|---|---|
| | oz. | drs. | lbs. | oz. | drs. |
| Common earth mixed with sand | 0 | 11·62 | 9 | 12 | 13·92 |
| Strong sand, or sandy stone | 0 | 15·47 | 13 | 0 | 13·52 |
| Potters' clay | 1 | 0·64 | 14 | 0 | 10·24 |
| Loose and moveable sand | 1 | 1·56 | 14 | 13 | 0·96 |
| Old masonry | 1 | 2·4 | 15 | 8 | 6·4 |
| Freestone or rock | 1 | 4·33 | 17 | 2 | 7·28 |

To use this table, suppose it should be required to ascertain the charge of a mine necessary for a two-lined crater, having its line of least resistance equal to ten feet, in a soil of potters' clay; first, cube the line of least resistance (or, in other words, multiply it three times into itself, that 10 × 10 × 10 = 1,000.) Then the solid content of the excavation being equal to 11·6 of the cube of least resistance; multiply 1,000 × 11-16, which will give 1833·326 cubic feet; again, multiply this last result by the number of drachms opposite potters' clay in the table—that is, by 16·64 drs. (which is the same as 1 oz. 0·64 drs.)—and the produce is 30506,54464 drs. or 119 lbs. 2 oz. 10 drs.

The rule, therefore, is, *multiply the content of the excavation in feet by the weight of powder corresponding to the soil in the table, and the product will be the charge.*

Vauban calculated, that for a mine necessary to blow up one cubic toise, or 287 cubic feet, it required, if

| | lbs. of powder. |
|---|---|
| Light earth mixed with sand | 11 |
| Common earth | 12 |
| Loam or strong sand | 15 |
| Clay or fullers' earth | 16 |
| Old and good masonry | 18 |
| Rock | 20 |

The following rule is given in the *Manuel Pratique du Mineur*:—To find the charge of an ordinary mine, established under ordinary earth, such as requires 12 lbs. per cubic toise (287 cubic feet) to raise: express the line of least resistance in feet, cube it, and in the result suppress the last figure on the right, then there will be to the left the number of pounds of powder required.

Suppose 10 feet to be the line of least resistance, its cube is 1000; suppress the last figure 0, and there remains 100 lbs. of powder, which is 19 lbs. less than Mouzé's table.

The size of the chamber depends on the quantity of powder to be lodged in it. Le Febvre and Mouzé are of opinion, that a small space being left round, the powder will produce a greater effect than when the chamber is made exactly to contain the box with the charge; but what this vacancy ought to be has not yet been determined; indeed, subsequent experiments have thrown some doubts on its efficacy.

A pound of gunpowder fills a cube of 30 inches; from which the dimensions of any cubical box, to contain a given quantity, can be calculated, simply by multiplying the number of pounds by 30, and extracting the cube root of the product: for instance, let it be supposed that the charge to be used is 2000 lbs. of powder; then $2000 \times 30 = \sqrt[3]{60,000}$ = a little more than 39. Now, a box of this size, 3 ft. 3¼ in. would be inconvenient, and could not even be got into a small breach: four small boxes should, therefore, be provided, so as to hold the required quantity.

While this work is printing, we have seen a fuse, most convenient for use, which possesses the extraordinary quality of burning under water, or exposed to any damp. It is the invention of Mr. JOHN HANCOCK of Fulham, and it is calculated to confer precision and safety on blasting greater than ever could have been anticipated. The lowness of its price is a further recommendation. Its form is a slight stick of deal, of any length, and his patent composition is inserted in a groove.

In the progress of cutting the Delaware Canal, four kegs of gunpowder, containing about 100 lbs., were used for a single *blast*, and it had the effect of rending in pieces more than 400 cubic yards of rock.

Hare, of the University of Pennsylvania, has contrived to ignite 10 or 12 blasting charges at once, by a galvanic discharge, with safety and advantage.

BLASTING-BELLOWS, or FORGE-BELLOWS. Every one is acquainted with the domestic or smith's bellows, the object of which is to supply the hydrogen evolved at the fire with oxygen gas, the fixation of which is the sole cause of the heat. But for smelting iron, and many large purposes, a greater supply of heat is required, and some bellows in iron furnaces are so large as to require the force of a 80-horse engine to work a pair of them, and to keep up a continued blast or roar. The various forges in the Royal Dock-yards are supplied by a set of cylinders, which work into an air-chest, and by creating a pressure of half a lb. to the square inch, supply 12 or 20 forge-fires with 5000 cubic feet of air per minute. A fall of water, passing near a fire, produces a current of air often sufficient for a furnace. That invented by Vaughan, for iron-works, furnishes 1200 cubic feet per minute. Of course, the space emptied by every stroke into the number of strokes per minute, is the volume of air expelled. The velocity of the air per minute is the above quantity in a minute, divided by the area of the nosel.

The variation of the barometer sensibly varies the heat produced by the same bellows, and, when high, more iron is made than when it is low.

BLEACHING. One of the most important chemical properties of oxymuriatic gas, or chlorine, is displayed in its action on the vegetable colors. Many of them it entirely destroys; and even those which are the most deep and permanent, such as the color of indigo, it renders faint, and changes to a light yellow or brown. This agency is exerted by it, both in its gaseous and its liquid form. The presence of water is, however, necessary. Hence, when the gas destroys color, it must, probably, be enabled so to do by the hygrometric water it contains. It is accordingly found, that, when freed from this, it does not destroy the color of dry litmus paper. The destruction of colour appears to be owing to the communication of the oxygen of the water present to the coloring matter: the chlorine attracts the hydrogen of the water to form muriatic acid, and the evolved oxygen unites with the coloring matter, and, by changing its constitution, alters its relation to light, so that the tint disappears. Such is the theory.

Berthollet applied the agency of oxymuriatic gas to the process of bleaching, and with such success as to have entirely changed the manipulations of that art. The method of using it has been successively improved. It consisted, at first, in subjecting the thread or cloth to the action of the gas itself; but the effect, in this way, was unequally produced, and the strength and texture were sometimes injured. It was then applied, condensed by water, and in a certain state of dilution. The thread, or cloth, was prepared as in the old method of bleaching, by boiling first in water, and then in alkaline lye; it was then immersed in the diluted chlorine: this alternate application of alkali and chlorine was continued until the color was discharged. The offensive, suffocating odour of the gas rendered this mode of using it, however, scarcely practicable; the odour was found to be removed by condensing the chlorine by a weak solution of potash: lime, diffused in water, being more economical, was afterwards substituted. Under all these forms, the acid, by decomposing water, and causing oxygen to be imparted to the coloring matter, weakens or discharges the color, and the coloring matter appears to be rendered more soluble in the alkaline solution, alternately applied, and of course more easily extracted by its action.

Lately, a compound of chlorine and lime has been employed, prepared by exposing slacked lime to chlorine gas: the gas is quickly absorbed, and the *chloride of lime*, being dissolved in water, forms the bleaching liquor now commonly employed, and which possesses many advantages.

In using it, the colored cloth is first steeped in warm water to clean it, and is then repeatedly washed with a solution of caustic potash, so diluted that it cannot injure the texture of the cloth, and which is thrown upon it by a pump. The cloth is then washed and steeped in a very weak solution of chloride of lime, again washed, acted on by a boiling lye as before, and again steeped in the solution; and these operations are performed alternately several times. The cloth is lastly immersed in very dilute sulphuric acid, which gives it a pure white color; after which it is washed and dried. Chloride of magnesia has been substituted, with great advantage, for that of lime, in whitening cloth for calico printing; the cloth, when lime is used, retaining a little of it, which, in the subsequent operation of clearing by immersion in weak sulphuric acid, forms sulphate of lime, which remains, and affects the colors when it is dyed; while the sulphate of magnesia is so soluble, that it is entirely removed.

Chloride of alumine has been employed to discharge the color of the Turkey-red dye, which resists the action of other chlorides, and is only discharged by chlorine gas, by an operation very injurious to the workmen.

Chloride of lime used in bleaching is an article of commerce made by exposing slacked lime, or hydrate of lime, to chlorine gas till saturated. The lime is spread on the floor of a closed room, with a stone floor. The chlorine is formed in a leaden vessel by mixing equal parts of black oxide of manganese and salt, and pouring an equal quantity of sulphuric acid, at 1·843, with as much water, and from the vessel proceeds a lead pipe to convey the oxy-muriatic gas to the lime-room. A double case receives steam so as to keep up the extrication of gas till all the salt is decomposed. The saturated lime is 1 chlorine and 1 lime, according to some theorists.

In some manufactories the lower part of the bodies are made of cast-iron, set in a pot furnace, and thus exposed to the action of a gentle fire. The upper edge of these cast-iron bottoms has a groove, into which is put the top part of the body, which is made of lead, and the joint is cemented with lime cement. —The top of the body is closed by a lid, cemented to it, and having 4 holes, the two first of which have round them grooves, about 4 inches deep, to form water joints. The first is a man hole, for the operant to enter the bodies, and rectify any derangement in the rotary apparatus, or knock off any pan scale. 2, placed in the centre, admits a vertical axis, with a handle, and cross bars of iron or wood sheathed with lead, by which the materials in the body may be stirred. 3, a hydrostatic funnel of lead pipe, to introduce the oil of vitriol as it is wanted. 4, another pipe, which conveys the chlorine or oxymuriatic acid gas into an intermediate vessel, containing water, to absorb and retain the muriatic acid, not changed into chlorine.

The quantity of materials operated upon at once is about 10 cwt. of rock salt, ground with from 10 to 14 cwt. of black manganese, which being introduced into the vessels, there is added from 16 to 18½ cwt. of sulphuric acid; specific gravity 1·65, or 75° Beaumé.

From this intermediate vessel, the chlorine gas is conveyed by a leaden pipe into the chamber containing the slaked lime, which is to absorb the gas. This chamber is built of silicious stones, cemented with a mixture of pitch and plaster of Paris, with two windows opposite to each other.

Bleaching liquid is then made by 1 lb. of fresh chloride of lime to 2½ gallons of cold water; specific gravity 1·02.—The test of strength is a solution of 1,000th indigo, and 100th with its sulphuric acid, in water in a glass tube, and the strength is inversely as the quantity which changes an indigo solution into brown.

Cotton or linen cloth is soaked in this solution for 6 hours. It must then be washed, and will be found light gray. Afterwards, it is left 4 hours in a mixture of 1 sulphuric acid to 25 of water, and washed again. It is then boiled 8 hours in alkaline ley made of potash and quicklime, or carbonate of soda, and again washed. Linen requires this 3 times. It is now immersed 5 hours in a weaker bleaching liquor than the first, and if linen, to be repeated; and afterwards, 3 or 4 hours in the sulphuric acid and water as above. The bleaching process is now finished, and the cloth perfectly white, but it must be twice washed, then squeezed, mangled, starched, and calendered.

Wool is bleached by steeping and stirring it repeatedly in a ley made of 5 river water to 1 of stale urine at 66°. It reduces coarse wool to half its weight. For fine wools, soap baths are employed, and it is wrung dry by a hook and winch. A further whitening is imparted by the vapour of sulphur in a close room for 6 or 12 hours, and passing afterwards through a soap bath.

Silk is bleached by scouring, in a strong soap bath, 5 oz. of soap to every lb. of silk. The silk is turned in on poles at the heat of 90°. It is then boiled in bags in a weather soap ley. A blue tinge is given by some litmus or indigo in the bath; and a perfect blue by sulphuring either in a sulphur room, or a dilute solution.

Rags are whitened for paper-making by mixing a solution of 3 lbs. of bleaching powder in the engine when in the state of half stuff.

Wax is bleached by passing chlorine gas for an hour or two through water, in which the wax is mixed in fine parts.

Prints and paper are whitened and cleansed by simple immersion in chlorine gas, or in the liquid form.

In bleaching, cotton goods lose a 10th of their weight, and linen goods a third. Lee's method of bleaching the fibres of flax (coloured steeping and rotting) has been abandoned. In bleaching linen, it is usual and necessary to mix one-half of muriate of lime in water.

When water is added to the chloride of lime, it effects its partial decomposition; one half of the chlorine leaves the lime, and dissolves in the water; and this is the bleaching liquid of the shops, which cannot cost more than a farthing a gallon. Sometimes this fluid is applied immediately to the substance to be bleached, but sometimes a weak acid is added to destroy the slight affinity of the chlorine for the lime, and the bleaching power of the fluid is increased.

The terms chloride and chlorine are used from respect to fashion; but the mode of making indicates that chlorine is simply muriatic gas, with an extra dose of oxygen, from the black oxide, or sulphuric acid, and, in fact, oxy-muriatic gas.

*Javelle Bleaching Liquor*, often called javelle ley, has the property of bleaching cloth, by an immersion of some hours only.—*Bleaching Powder.* The proportions yield a liquor similar to javelle ley; $2\frac{1}{2}$ lbs. of common salt, 2 lbs. of sulphuric acid, $\frac{3}{4}$ lb. of black manganese, and, in the vessel where the gas is to be condensed, 2 gallons of water, and 5 lbs. of potash, which should be dissolved in the water. This liquor may be diluted with from 10 to 12 parts of water; and, after this, it bleaches more speedily than the liquor itself.

Chlorate, or oxymuriate of potass, mixed with muriatic acid, and diluted with water, forms an *extemporaneous* bleaching liquid, which may be instantly made, for it is only necessary to put a few grains of the oxymuriate into a tea-spoonful of muriate of soda. and dilute it with water, and it will remove almost all kinds of spots from linen, except those made by oily or greasy substances.

*Or*, put a small quantity of red lead into muriatic acid, when chlorine, or oxy-muriatic acid, is instantly evolved; add water to the mixture, and spots, stains, or colour, are instantly removed.

*Bleaching by Potatoes.*—This method of bleaching consists in substituting, instead of the soap employed in the ordinary process, an equal quantity of potatoes, which have been previously three parts boiled. The linen is placed in a copper, and left to steep for nearly an hour; it is then put into a caldron of boiling water, from which every piece is taken out separately, and rubbed with the potatoes in the same manner as with the soap. After the linen has been well rubbed, rolled, and wrung, it is replaced in the caldron along with potatoes, boiled to the same degree as above. The whole is left to boil for half an hour. The linen is then taken out, rubbed with care, wrung anew, and again plunged into the caldron for a few minutes. It is afterwards rinsed 2 or 3 times in soft water, steeped about half an hour in cold water, pressed, and hung up to dry. The whole operation may be concluded in about $2\frac{1}{2}$ hours. The linen thus bleached is perfectly white, without the least trace of grease or stains. Kitchen linen, which has always the smell of tallow, becomes perfectly inodorous after having been bleached by this process.

BLEBS, are the bubbles which stand on proof spirits in a phial when shaken. When they do not stand it is under proof. There are compositions for making them without the strength.

BLEEDING AT THE NOSE.—Dr. Hufeland has lately published the following new mode of stopping the discharge of blood from the nose. The usual remedies, as the mineral acids, ice to the nape of the neck, &c. having failed to check it, gum arabic powder was ordered to be blown up the nostrils, by means of a quill, and it immediately succeeded in stopping the discharge.

BLENDE, is sulphuret of zinc, and its common ore. It contains zinc 60 or 70, iron from 4 to 12, and sulphur 29 to 36.

BLIGHT, is a general name for various distempers incident to corn and fruit-trees. There appear to be, at least, three distinct species of it.

The *first* originates in cold and frosty winds, in spring, which nip and destroy the tender shoots of the plant, by stopping the current of the juices. The leaves wither and fall; the juices burst the vessels, and become the food of numerous insects, which are often mistaken for the cause of the disease, while they are really an effect of it.

The *second* originates in a sultry and pestilential vapor, and happens in summer, when the grain has attained its full growth.

The *third* arises from *fungi*, which attack the leaves or stem of herbaceous and woody plants; but more generally grasses, and particularly the most useful grains. It generally assumes the appearance of a rusty-looking powder, which soils the finger when touched. There are several sorts of these *fungi*, known to farmers under the names of *red rust*, *red gum*, &c. The only means of preventing the effect of blight is proper cultivation.

BLISTERING OINTMENTS *(for horses.)* In 4 ozs. of lard mix 1 oz. of powdered cantharides, and 1 oz. of oil of turpentine. *Or*, with 2 drs. of sulphuric acid carefully dropped into the oil. *Or*, with half an ounce of the powder. *Or*, with 1 oz. of elder-flowers ointment to the first.

BLOCK MACHINERY, wrought by steam-engines at Portsmouth, for sawing large timber to suitable pieces, for forming sheaves, making the iron pins, and manufacturing the shells of the blocks, invented by Brunel. There are, for these purposes, circular saws, boring machines, mortising engines, shaping engines, scoring engines, broaching engines, facing lathes. Two 30-horse engines and 8 or 10 men cut out and finish 450 blocks per day, equal to the manual labour of 50 or 60 men, and more equally and truly performed. The importance of the fabric is made evident by the fact that a 74-gun ship requires 1270 blocks, besides dead-eyes, &c.

A block is merely a pulley, which facilitates the application and direction of power. It decreases force by the amount of friction, but force could not, in many cases, be applied without it. A system of blocks, like that of pullies, by diminishing velocity, adds proportionally to power, deducting for friction. This last, however, is greatly reduced by the even working of the Portsmouth blocks.

BLOOD, is the fluid, (sp. gr. 1·053) which by chemical reaction, at the lungs and skin, connects the galvanic forces, and continues and preserves the life of an animal. By fixing oxygen in the lungs, it acquires its heat of 98° and its red colour, and drawn by the heat through the system of arteries, it communicates its renewed heat to the body; diffused in the muscles, glands, and cellular substance, and coming into contact with nitrogen of the atmosphere, its colour is changed to purple, and it returns to the heart and lungs for oxydation. There is a circulation, but the two sets of vessels are wholly unconnected, and though the connection is pertinaciously asserted, yet no vision, even of the microscope, could ever trace it. It is one of the too many doctrines which books reflect from one to another. The true circulation is one which brings the blood, in different chemical states, twice into contact with the atmosphere; but, in the days of Hervey, the compound chemical character of the atmosphere was not suspected. In like manner, when electric theories were invented, nothing was referred to the atmosphere, which the first electricians considered an uncompounded element. Priestley and Galvani enabled us to reason on these subjects with more precision.

The blood examined by the microscope appears to contain atoms of the *shape* of mill-stones. Mechanically, on cooling, it separates into two substances; the red crassamentum, 1, and the transparent serum, 3. Acids and alcohol coagulate it, and, examined chemically, its components in man are, for the *serum* of 1000, water 905, albumen 80, and 15 various compounds of alkali; and *cruor*, 360 fibrin, and 640 colouring matter.

The specific gravity of arterial blood is 1·0527, but it varies. The serum is to the crassamentum as 56 to 44 in health, but in some diseases, as in cholera, as 40 to 60. The venous blood turns from brownish red to scarlet in the air, and also in its passage through the lungs. The serum has specific gravity 1·0287, and it reddens litmus. At 159°, or in alcohol and acids, except acetic, it coagulates, and resembles the white of an egg. It consists of 90·5 water, 8 albumen, 1·26 soda, salt, &c. &c.

The crassamentum consists of fibrin, (1) and colouring matter (2.) The former is 51 carbon, 8 hydrogen, 18 nitrogen, and 23 oxygen. The colouring matter is half red oxide of iron. It consists of globules. By washing the crassamentum in water, the colouring matter is obtained by evaporation, as dark red, or brown red powder.

Dr. Marshall Hall, in *the Cyclopedia of Practical Medicine*, states that the blood, in the microscope, presents the appearance of globules floating in serum. By washing in water, the cruor divides into white insoluble *fibrine*, and colouring matter called *Hæmato sine*, which last, in 1000 parts, is 275 oxide of iron, 410 sub-sulphate of iron, 110 magnesia, 110 chalk, and 95 carbonic acid. *Serum* with heat, or in alcohol, becomes albumen, soluble in cold, but not in hot water. Arterial blood is less abundant than venous, separates more readily into cruor and serum, contains less albumen, is less viscous and less serous, and has less specific gravity. The globules are larger in the fœtus than in the mother, and double those of an adult man. The blood is subject to morbid changes, and to excess or deficiency: and the cruor, the serum, and colouring matter, often vary in proportions. Bad air and bad food may vitiate it. The nervous system and blood act and re-act. In malignant fever, the cruor is too thin, and the serum dark. In typhus, and yellow fever, there are also changes. In Asiatic cholera, it is dark and thick. In inflammation, it is buffed and cupped.

Blood-letting, is adopted in inflammation, diseases of the head, and some kinds of fever, but always to be used with caution. The force of the beat of the heart should be considered, and if feeble with a feeble pulse, should be avoided. The stethoscope is the test, and the pulse. The quantity is that which the erect patient can bear, till such approaching faintness as does not arise from mere fear. Repetition renders the blood dense and sizy. When exhaustion arises from loss of blood, the tincture of henbane, or hyosciama, made by digesting an oz. of dried black leaves in 8 ozs. of proof spirit, given in a dose of 1 fluid drm. is the safest and most efficacious sedative.

Blood-wort, *bloody dock*, *garden patience*, *great water dock*, *sharp-pointed dock*, *monks rhubarb*, *bastard monks rhubarb*, all have roots, which have the same qualities as foreign rhubarb, but the dose must be nearly doubled. And they are used in powders, tinctures, and infusions, instead of rhubarb; they are eaten while young as potherbs, and are used in dyeing.

BLOSSOMS.—To preserve blossoms of wall-fruit. The injury is produced, not by the cold of the night, but by the sudden action of the *morning sun*, after being enfeebled by cold; the mischief may therefore be prevented, either by raising the temperature of the plant before the sun shines upon it, by flues, or by intercepting the rays till the plant has acquired a suitable degree of heat.

BLOWING MACHINES, for admitting and expelling air, are used for many purposes, sometimes for mechanical force, but more commonly for conveying air and its oxygen into contact with combustible substances, in blasting machines.

BLOW-PIPE, an article long employed by jewellers and watch-makers, in soldering different parts of ornaments; and, within a comparatively few years, become indispensable in the apparatus for chemistry and mineralogy.

The blow-pipe employed for common purposes, by watch-makers, jewellers, and the artizans in many branches of the Birmingham manufactures, who solder metals, fabricate metallic toys, form glass pendants for chandeliers, and draw out glass tubes for thermometers and barometers, is merely a conical tube, in length varying from eight to twelve inches, of sheet brass, with an aperture a quarter of an inch in diameter at the wider end; and gradually diminished to a very small one, for the efflux of the air at the other, near which it is bent at almost a right angle.

The blow-pipe employed for chemical and mineralogical purposes, whether formed of brass, tin-plate, silver, platinum, or glass, is varied in length according to the sight of the operator, as it must allow the substance (usually called the assay,) when subjected to the flame, to be only at that distance, most distinctly and clearly perceptible by the eye, and which is from six to eight inches. The mouth-piece is flattened or oval, and frequently formed of ivory; at some part of the tube is a bowl, or enlargement, wherein the vapour of the breath condenses, and remains in moisture; and moveable nozzles for a stronger or finer blast, with each aperture truly round and smooth, and in different sizes.

There are several compound blow-pipes, constructed to be supplied with air from bladders, or reservoirs, filled by the mouth at intervals; others are supplied by a pair of double bellows fixed beneath a table, or by equivalent contrivances; and others are adapted to consume mixed gases from gas-holders, bladders, or reservoirs, or only mixed before effluxion at the fine jet, to preclude explosion.

Each of the compound blow-pipes, called Gurney's, Brooke's, Tilley's, Clarke's, and Toft's, (cheapest,) has its peculiar advantages in using, but is expensive to a person of limited income. That which I employ cost very little, because the more expensive parts, *taps*, are useful in other processes, I have a piece which by a screw is fixed to a table. The piece is perforated, and tapped for screws, on its upper and under surfaces; likewise on the outer and two sides. Into the top I screw a cock-spur gas tap, to which I have three jets of different-sized perforations, also an extra piece filled with fine loose iron filings, for insertion betwixt the pipe and jet, when consuming gas. Into the lowest aperture I screw my tap, connected with a reservoir, (bladder, or elastic gum cloth;) and likewise screw taps into the two sides. The outer hole admits to have screwed into it an angular piece with a valve at the end inserted, and into the other end of this screws a blow-pipe, by which I can fill my reservoir at convenience. Thus either one or more bladders can be attacked, with distinct or mixed gases, at pleasure; or only common air can be used, as the occasion may require. At present, I have not had the disaster of an explosion; neither do I expect it, as each gas mixes with the other only just when expelled from the pipe.

When the simple blow-pipe is used, a candle of tallow, or of wax, with a thicker wick than common, is employed to supply the flame. Convenience is the first object, and these are so; but the radiant heat of the assay so soon melts the wax or tallow, and causes the wick to consume so quickly, that even the trouble of snuffing is a drawback in important processes. I find a lamp, made with a beak into which the wick is held by a wire collar, and over which a hood can be readily placed, very useful; the wick is of soft cotton roving, clean, dry, and scarcely twisted, and olive-oil is best; but purified rape-oil, and hog's lard, will be found the only proper substitutes. The oils should be kept corked up when not in the lamp, and the wick must be destroyed. This lamp will answer all purposes of the operator, with the compound blow-pipe, when gas is not used; and the bright clear flame, devoid of smoke, can be managed most advantageously.

With the blow-pipe and lamp, or candle, the operator may effect an assay, with heat more ardent than that of a furnace. In a few minutes he can ascertain the general nature and properties of even the most valuable mineral, or chemical compound, by the minutest portion thereof, in reference to fire; and, free from the uncertain conjecture of what occurs in the centre of a furnace, wherein such an experiment might be made on a large scale, he can witness the commencement and the conclusion of all the appearances, and their proximate causes; the chemical, or the mechanical mixture, or conglomeration of the components; and ascertain and determine results, which else would require large furnaces, great quantities of substances, cumbrous apparatus, and many hours of attentive investigation. The only drawback on its excellence is, its not determining the proportions of the components.

With the simple blow-pipe, most readily, and with least fatigue to *blow*, so that the stream of air may flow uninterruptedly against the flame during the continuance of the experiment, even when that is occasionally several minutes; the operator must attend to these particulars:—First acquire the practice of breathing through the nose, while the tongue touches the roof of the mouth, and the lips are closed; this will probably be effected in from ten to forty minutes. The muscles of the mouth will soon conform to this fresh kind of exertion. Next, breathe through the nostrils, and yet keep the cheeks distended with air all the time; afterwards inspire several supplies of air while the cheeks are filled; and at length, with the cheeks full, easily compress them, and let the air flow through the pipe, even while inhaling a supply by the nostrils, keeping the tongue to the roof, unless when instantly supplying air from the lungs. The lips will be subject to lassitude on the first trials; but determined perseverance is requisite, and with this the operator will successfully blow for any length of time without much inconvenience.

The next important remark is, that wherever the operator wishes to most readily effect his object, he must be secure from any current or draught of air, that his exertions may not be unnecessarily lengthened. And also, that there is no subject he may possess, but will be worse for violently blowing; and rarely refractory to continued moderate exertions.

Let the wick of the lamp or candle be a little bent, or the candle oblique. Direct the stream of air from the pipe along the wick, but without striking the flame, and notice that when the aperture is too large an irregular cone will be formed; and when it is not round and smooth, the cone will be ragged or rough. But when the orifice is proper, the cone will have an inner portion, light blue, pointed, and an inch long; this point has the most intense power; and an outer portion, vague, brown, varied in length, and with diminished power. By the former, carried brilliantly and equally on all parts of the assay, which never needs to be larger than a grain of mustard-seed, the operator can *reduce*, or *de-oxidate;* and by the outer, all the combustible particles will quickly be saturated with oxygen, and the substance be *oxidated*, not acidified. A small bit of grain tin is useful to ascertain the reducing flames, and the degree of exertion needful to keep it reddish white on charcoal.

Dr. Farrady says, the aperture of a blow-pipe should be the fortieth or fiftieth of an inch diameter. The jet end may be platina. The mouth and cheeks should act independently of respiration by the nostrils, so as to maintain a constant current. Success depends on knack and practice. For ordinary purposes a tallow or wax candle, or lamp wick are sufficient, but for great heats broad flat wicks are used. The blast should be directed a little above the wick, and from a candle inclined a little upwards to prevent guttering. The greatest of the blow-pipe flame is at the extremity of the blue cone, where the combustion is complete, that is, where the hydrogen and carbon of the wick are in equilibrium with the oxygen, and fix its maximum quantity. There should be neither flame nor smoke at the extremity. When oxygen gas, from a caoutchouc bag, or vessel, is urged through the pipe, the heat is the greatest known to art. Sometimes condensed oxygen is forced into vessels, and a strain produced by opening a cock. Hydrogen, too, has been used instead of lamps with oxygen, and the effect is more powerful, but attended with danger of explosion. The substance should be fixed on sound charcoal, or in a platina spoon, or on white clay. With oxygen and hydrogen platinum runs in drops, and palladium melts like lead; every substance yields.—*Simeon Shaw.*

BLUE, PRUSSIAN, is a colouring pigment, of a pure dark-blue colour, a dull fracture, inodorous and insipid, insoluble in water, spirits of wine, or ether; it is soluble only by the action of corrosive alkalies. The discovery of this colour was accidentally made by a manufacturer of colours, who, with the intention of precipitating the colouring matter from cochineal, with which alum and vitriol of iron were dissolved, procured some alkali, which had been heated with some animal matter, and it produced a beautiful blue precipitate. Discovering that the alkali had acquired this power of forming a blue precipitate of iron, on account of its mixture with animal oil, he learned to prepare it in a more simple way, since all animal substances, and even all vegetables, which contain much azote, give the same result. The addition of alum gives to this blue more body, and a brighter colour. It is a prussiate of iron (52 parts red oxyde of iron, and 48 of prussic acid.) The alumine added amounts to from 20 to 80 per cent.; but the greater the quantity, the poorer is the quality of the blue.

BLUE, SAXON, is made by digesting an oz. of indigo with 4 oz. of sulphuric acid for an hour, add 12 oz. of water, and filter in a cloth dipped in alum water.

*Blue Vitriol*, is the sulphate of copper, whose constituents are 32 copper, 32 sulphuric acid, and 36 water. It is a decomposition of copper pyrites, and when prepared is sold in blue crystals, and much used in the arts, &c.—*See* SULPHURIC ACID.

*Blue, for Artists, from Indigo*, is made by exposing the solution in the blue vat of dyers to the air, in a shallow vessel, and the precipitated indigo, dried and digested, is pure indigo, like ultra-marine.

BOAT, a vessel propelled by oars. They are light or strong, sharp or flat-bottomed, open or decked, &c. according as they are intended for swiftness or burden, deep or shallow water, &c.

The *barge* is a long, light, narrow boat, employed in harbours, but unfit for sea.

The *long-boat* is the largest boat belonging to a ship, generally furnished with sails, and is employed for cruising short distances, bringing heavy articles on board, &c.

The *launch* is more flat-bottomed than the long-boat, which it has generally superseded.

The *pinnace* resembles a barge, but is smaller. The *cutters* of a ship are broader and deeper than the barge or pinnace, and are employed in carrying light articles, passengers, &c. on board.

*Yawls* are used for similar purposes, and are smaller than cutters.

A *gig* is a long, narrow boat, used for expedition, and rowed with 6 or 8 oars.

The *jolly-boat* is smaller than a yawl, and is used for going on shore.

A merchant-ship seldom has more than 2 boats, a long-boat and a yawl.

A *wherry* is a light, sharp boat, used in a river or harbour for transporting passengers.

A *punt* is a flat-bottomed boat, chiefly used for one person to go on shore from small vessels.

A *skiff* is a small boat, like a yawl, used for passing rivers.

A *moses* is a flat-bottomed boat, used in the West Indies for carrying hogsheads from the shore to ships in the roads.

A *felucca* is a large passage-boat, used in the Mediterranean, with from 10 to 16 banks of oars.

A *scow* is a large, flat-bottomed, heavy boat, about 30 ft. long, and 12 wide; sometimes called a *gondola*.—*See* LIFE-BOAT and SHIPS.

BOILERS, are of various forms, but for steam-engines, especially for vessels and carriages, Clark's tubular boilers are preferred. They are bent in curves, and constantly full of water, exposed to the action of the fire, and so combined with the condenser, that the same pure water serves again and again, without accumulating obstruction. They effect the work with a large saving of fuel, and remove the danger of explosions.

BOILING, is the phenomenon which follows such a diffusion of heat through a mass as would radiate the whole into gas, but for the reaction of the atmosphere. This takes place in water at 212°, but varies with the barometer. In alcohol at 173°. In ether at 100°. In linseed-oil at 640°. In solution of muriate of lime, 252°. In sulphuric acid at 600°. In saturated salt-water 225°.

Bodies are dissolved or permeated in

less time by boiling fluids, because their motion is then greater, and to their first fluid force is added their new gaseous force. It is the penetration of the gas which breaks up and dissolves a solid body by boiling it. A piece of meat boiled in water is penetrated by its gas, not by the water, and a steamer cooks provisions on the very same principle as actual immersion in water, but with more economy, because part of the substance is dissolved by the water.

Motion of the atoms is the primary cause, and those of water or fluid are merely the convenient instrument for transferring the motion of oxygen atoms, fixed in the fire, called heat, to the substance boiled.

Boiling Apparatus.—Mr. Perkins has recently obtained a patent for a new mode of boiling. It consists in placing within a boiler, of the form common to the purpose to which it is applied, and of all capacities, from coffee-pots to steam-boilers, a vessel so contrived that it may, by slight stays, be kept at equal distances from the sides and the bottom of the boiler, and have its rim below the level of the liquid: the inner vessel has a hole in the botttom, about one-third of its diameter. On the application of the fire to the boiler, the heated liquor rises in the space between the two vessels, and its place is supplied by the descent of the column in the inner vessel, or, as Mr. Perkins calls this part of the apparatus, the *circulator;* for the ascending portion having the space it occupied supplied by the descending liquid in the centre, and the level of the centre being kept up by the running in of the heated portion which has risen on the sides, a circulation rapidly begins and continues: thus bringing into contact with the heated bottom and sides of the boiler the coldest portion of the liquid. By this process, the rapidity of evaporation is excessive, far exceeding that of any method previously known; whilst the bottom of the boiler, having its acquired heat constantly carried off by the circulating liquid, never burns out, nor rises in temperature many degrees above the heat of the liquid.

BOLES, or Red Earths, are *Armenian Bole*, a deep red, burns rather harder, and to a brighter red.

*Lemnian Earth*, is pale flesh red, burns to a dusky yellow. The red and yellow burn to red.

*German Bole*, is pale yellowish red, and burns without changing colour.

*Bole of Blois*, is pale red, with an orange cast, effervescing violently with acids, and burns to a stony hardness and dark red.

*French Bole*. Pale red, with white and yellow veins, heavy, close, slightly unctuous, not colouring, slightly astringent; burns very hard, but of the same colour; and is astringent in powder.

*Barros*. Fine florid red, heavy, harsh, colouring, strongly astringent, burns brighter but not harder. It is used in dysentery and in dentifrices.

*Mahogany Earth*, is pale red, from the Isle of Wight, and used in painting, and to stain mahogany colour.

*Ruddle, or clay-iron ore*, is dusky red, and very heavy. It is used as a colour for marking cattle, and also as an iron ore.—*Hard ruddle or red chalk*, is deep red, burns hard and darker; and is used as a crayon.—*See* Ochre.

*Common Bole*, is red chalk ground and made into cakes. It is used in tooth-powders.

*Spanish Brown Earth*, is fine deep red, with a purple cast, burns hard and paler. It is used as a colour, and as a polishing powder.

*Indian Red Earth*. Fine purple, extremely heavy, burns hard, with no change of colour. It is used as a paint.

*Venetian Red Earth*, is dull red, not heavy, burns hard, and of a dull colour.

*Brown Red Ochre*. Very deep brown red, extremely heavy, firm, very rough, colours very much, slightly altered by burning.

*Terra di Sienna*, is deep brown or coffee-colour earth, light, smooth, and glossy, when wetted marks a fine yellow, and burns to a pale reddish brown. An inferior sort is found at Wycombe.

BOLETUS, the sponge of the oak and ash, used as a styptic.—*See* Agaric.

BOLOGNA STONE, is a preparation of a rock near Bologna, which, after ignition, powdered and dried as paste, retains the solar light for a considerable time.

BONES, in men, consist of 81·9 phosphate of lime, 3 fluate of lime, 10 lime, and 5 magnesia, soda and carbonic acid. 100 calcined is 63. The phosphate of lime is above half gelatin. Madder and log-wood, in food, tinges the bones in 2 or 3 days, even a deep scarlet, but on desisting they return white. Bones are used in many processes, as for bone black, hartshorn, gelatin, &c. They are also ground, &c. and largely used as manure, even human bones.

*Bone Ash*.—This is a secondary product, obtained in the distillation of hartshorn from bones. The still or retort being opened, the carbonaceous residuum is left to burn to whiteness.—The calcined bones thus obtained are then ground to the required fineness, according to the use to be made of them. If for adding to lime mortar, or manure, a coarse powder is sufficient; if for polishing, under the name of *burnt hartshorn*, the powder must be very fine.—Bone ash is also used to form the vessels, or bed on which silver is refined, by lead; and as it is a phosphate of lime, and cheap, it serves as the raw ingredient from which phosphoric acid and phosphorus are obtained.

BOOK-KEEPING, is the art of keeping books, so that a trader may know what he owes, and what other people owe him. Its first quality is a correct register of every transaction, and its next, the posting each to its separate account. The balance at certain periods is the assets of stock, cash, bills, and good debts on one side, and the obligations in debts, acceptances, &c. on the other. On such frequent balances depend the success of every course of trade and mercantile pursuit. Stock should be taken only at prime cost with deductions for waste and fashion, and due allowance made for uncertain debts. A prudent trader never expends above a third of his apparent profits, as determined by his half-yearly or yearly balances.

BOOKS.—An author who writes a successful book and sells it to a bookseller, was by the act of Anne entitled to the reversion in 14 years, for the benefit of himself and family; but, in 1814, a *Gotham* parliament, under pretence of serving authors, postponed the reversion for 28 years, so as in effect to reduce the author's further benefit to the low chance of his surviving for 28 years! Perhaps this was one of the most extraordinary instances of legislative injustice and absurdity on record. The act of Anne, passed under Addison, Steele, Halifax, &c. &c. had guarded the necessities of authors by limiting their power of assignments to 14 years and "*no longer*," in express terms, but by the absurd new law, even if the 28 years are not formally expressed, the assignee bookseller may claim the author's entire life interest, so that as a needy author cannot attempt to make any reservation, he cannot make any sale, or must forego all right. Not one book in 500 survives 28 years, therefore the present worth is not an object to contend for, and, of course, is yielded as a matter of course. A committee of publishers directed this bill, and authors either had no committee, or being no corporation, they implicitly relied on the supposed wisdom of the legislature. The lease of a book for 14 years afforded the author the prospect of a fine on renewal, but this a sapient parliament destroyed, and as a pretended *benefit* to literature.

Since the spread of education in Europe, the trade in books has become a very considerable branch of domestic trade, and in England employs and supports at least 40,000 families as printers, binders, vendors, &c,

BORAX, is a compound of soda and boracic acid, separable by boiling, and by mixture with some sulphuric acid, in which last may be decomposed, by the powerful alkali potassium, and the result is boron, a deep brown powder, reconvertible into acid by heat in the air.

BORING, is an important operation, and properly a regular trade of skill and science, whether employed for raising water through strata, for draining stagnant water, or for determining the mineral products of the inferior strata. It is effected by iron rods, joined by male and female screws. They are from 4 to 5 ft. each, and 1 or 2 inches square. A chisel or pick is fixed to the bottom, and occasionally the rods are raised, and a wimble fixed, which by turning brings up the dust, and shows the nature of the strata penetrated. The mode of working is by turning and letting fall, but the operation is often very tedious. Tackle to raise is also necessary, as weight in great depths becomes considerable. The expense is trifling when only clay and marl are to be bored, but when whinstone and rocks intervene it is necessarily considerable. Every good farm ought to be provided with lengths for draining, and determining the subsoil for 20 or 30 ft., and every parish should have in the vestry tools to bore for water in desirable positions, as well as to drain bogs, &c. &c. Before boring, either for water or for minerals, the general character and direction of the strata should be examined and considered.

In boring cast-iron, the velocity is always 78·54 ft. per minute, and any other velocity is disadvantageous to the tools, and heats the metals. In Turning, the velocity is double that of boring, but, in both, the surface acted upon is constantly equal. If the revolution in boring is 25 per minute for 1 inch, it is 0·25 for 100 inches; and, in turning, if 50 for 1 inch, it is 0·5 for 100 inches.—*Brunton.*

Different metals require different degrees of velocity.—*Galloway.*

*Boring square or other shaped holes.*—The tool consists of an auger, formed like the ordinary screw-auger; the twisted part is enclosed in a case or socket, extending from the upper part of the twist down to the cutting edge: allowing the small entering screw only to project beyond it. The external form of the socket is either square or otherwise shaped, according to the intended form of the hole to be bored, a large portion of its sides being cut away to allow the chips to escape. The lower end of the socket is made of steel, with a sharp cutting edge around it, bevelled towards the inside. The cutting edges are not formed in right lines or straight, but are made concave, so as to cause the angular points at the corners to enter the wood first; this causing it to cut with greater ease, and more smoothly than it otherwise would. The upper part of the socket is formed into a collar, which works freely on the rounded shank of the auger, just above the twisted part of it, and is retained in its place by a pin and other appendages. When a longitudinal hole, or mortise, is wanted, two or more augers are placed side by side, each furnished with its separate socket.

It bores a square hole, with well defined angles, with nearly the same rapidity as a round one of the same diameter, forming it with a degree of truth unattainable by the ordinary methods.

**BOTTLING.** Let the article be clear, since it does not clear in bottle. Fine weather should be chosen and strong smells avoided. The cask should be tapped a day or two previous and the bottles clean and quite dry. They should be of one size, and laid horizontally in the bin with their heads and bellies alternately. The corks should be driven in with a wooden mallet, and dipped in a vessel of melted wax or rosin.

A machine has been constructed for the purpose of trying the strength of wine-bottles. The bottle to be tried is held at the neck by means of a lever, having 3 branches, which grasp it below the ring; being then filled with water, it is connected by pipes, with a forcing-pump, the pipe having a cap furnished with leather, which is firmly held down by the apparatus upon the mouth of the bottle; the pressure upon the parts here increases with the pressure of the water within the bottle. Besides the pump, levers, and connecting pipe, there is also a manometer, connected with the interior of the bottle, to show the pressure exerted. Bottles intended for brisk champagne or burgundy, being tried, were found to break with a force of between 12 and 15 atmospheres; exerted from within outwards, and a few rose to 18 atmospheres.

*Bottles tainted with bad smells.*—Put into them some pieces of grey or brown paper; fill them with water; shake the bottle strongly; leave them then a day or two in this state, when if necessary repeat the process.

*Graduated bottles* are sold which contain an exact cubic inch. Tubes also, containing a cubic inch of fluid, are graduated to 20ths or 50ths. Chemists keep them graduated to various measures and weights of fluids.

*Specific gravity bottles* are made graduated, and marked to the standard of distilled water, and furnished with a separate weight for comparison, with the same bottle filled with any other liquor.

Mr. J. Marsh has employed with success the following method of taking off the bottoms of phials, &c. :—I pour a small quantity of sand or emery into the angular turned-up part of the vessel, with a few drops of water to moisten it; then by means of a piece of wood having a sharp point, I press the moistened sand, &c. into contact with the glass, and by gently turning the bottle round, bringing the point of the wood and the sand into contact with every part of the lower end of the phial in succession. By these means the surface is quickly scratched, and immediately after a fracture takes place all round the bottle, which instantly separates the bottom.

**BORACIC ACID**, exists in several small lakes in Tuscany, at Volcano, one of the Lipari Islands, and in the hot springs near Sasso, in the Florentine territory, from whose waters it is deposited by natural evaporation. It is easily obtained also from borax, a native salt, composed of this acid and soda, by dissolving it in boiling water, and gradually adding sulphuric acid to engage the soda: the boracic acid is in this manner set at liberty, and is deposited in crystals on the cooling of the liquid: these, when washed with cold water and dried, are perfectly pure. Boracic acid was discovered by Sir H. Davy to be a compound of a peculiar base, which he called *boron*, and oxygen, in the proportion of 8 parts of the former to 16 of the latter. Its principles are separated both by means of galvanism and by the action of potassium. Boron is a tasteless and inodorous substance, in the form of a greenish-brown powder. It is insoluble in water, ether, alcohol, and oils; nor does it fuse when subjected to the strongest heats. By exposure to common air, it gradually becomes oxygenated, and, when heated in oxygen gas, burns vividly, and is converted into boracic acid.—Boracic acid is sometimes employed in the analysis of minerals, and for soldering metals in the arts.

The most important combination formed by boracic acid is that with soda, commonly called *borax.* It is brought into Europe in an impure state, from the East Indies, under the name of *tincal*, and is understood to occur principally in certain lakes, from whence it is obtained by evaporation. It is also reported to be dug from the earth in Thibet, and to exist in the mines of Riquintipa and Escapa, in South America. Its manufacture consists in boiling carbonate of soda with the calcined tincal, in order to saturate its excess of acid: 12 lbs. of carbonate of soda are requisite for every 100 lbs. of washed tincal, in the water: the ley is left to cool gradually and crystallize.

BORDEAUX WINES, are the finer red wines of the country round Bourdeaux, and the best which France produces. They contain but little alcohol, keep well, and even improve by removal. As the original fermentation is complete, they are, if judiciously managed, less subject to disorder and acidity than the Burgundy wines. None of the very best quality, however, is exported pure: a bottle of the best *Châteaux-Margaux*, or *Haut-Brion*, is a rarity hardly to be procured in Bourdeaux itself, at the rate of 6 or 7 francs a bottle. For export, the secondary growths of Médoc are mingled with the rough Palus. The red wines of the Bordelais are known in England and North America under the name of *claret*. They have less aroma and spirit, but more astringency, than the Burgundy wines. The Bordelais are the safest wines for daily use, as they are among the most perfect of the light wines, and do not easily cause intoxication. They have been accused of producing the gout, but without reason. Persons who drench themselves with Madeira, Port, &c. and indulge in an occasional debauch of claret, may, indeed, be visited in that way; because a transition from the strong brandied wines to the lighter is always followed by a derangement of the digestive organs.

The principal vineyards are those of Médoc, Graves, Palus and Vignes Blanches; after these, those of Entredeux-Mers, St. Emilion and the Bourgeais are the most important. The first growth of Médoc are the famous wines of Chateaux-Margaux, Lafitte, and Latour.

The *Lafitte* is characterized by its silky softness on the palate, and a perfume partaking of violet and raspberry.

The *Latour* is fuller, has more aroma, but less softness.

The *Chateaux-Margaux* is lighter than the *Latour*, and delicate, like the *Lafitte*, but has not so high a flavour.

Of the second growth, we may mention the Rauran and the Leoville. The average produce of the first growth is 100 *tonneau* (of 217 gallons each.) The soil of Médoc is a sandy and calcareous loam. The gravelly lands (*les Graves*,) to the south and west of Bourdeaux, produce the *Graves*.

The first growth of the red *Graves* is the Haut-Brion, which rivals the first growth of Médoc; it has more colour and body, but is inferior in aroma and taste.

The principal white *Graves* are St. Bris and Carbonieux. The best Médoc ought to be kept 3 or 4 years before removal; the *Graves* 5 or 6.

The wines of *Palus*, which is a bed of rich alluvial deposits, are inferior to the preceding; they are stronger and more deeply coloured than those of Médoc. Being hard and rough, they are improved by a voyage, and are principally sent to the East Indies and America as *vins de cargaison*, or are mixed with Médoc, which is intended for exportation. By the voyage they become more light and delicate, but are not to be compared with the growths of Médoc and the *Graves*. The best are Queyries and Ferrand. The former are deeply colored, and have much body. Age gives them an agreeable aroma, resembling that of a raspberry.

Among the *white* Bordelais wines, besides those already mentioned, the finest growths are Sauternes, Preignac, Barsac, and Bommes. Martillac and St. Medard are of a good quality, and have lightness and body. Dariste, formerly *Dulamon*, is equal to St. Bris and Carbonieux.

Among other red wines are the Bourgeais, which are of a fine color, and acquire, by age, lightness, and an agreeable almond aroma: of all the Bordelais wines, they most resemble the Burgundy wines.

BOX, the wood of a shrubby evergreen tree, 12 or 15 ft. high, which has small, oval and opposite leaves, and grows wild. The wood is of a yellow color, close-grained, very hard and heavy, and admits of a beautiful polish, and on these accounts is much used by turners, engravers on wood, carvers, and mathematical instrument-makers. Flutes and other wind-instruments are formed of it; and furniture, made of box-wood, would be valuable were it not too heavy, as its bitter quality would secure it from attacks of insects. In France, it is much in demand for combs, knife-handles and button moulds. Oil distilled from the shavings has been found to relieve the tooth-ache, and to be useful in other complaints; and the powdered leaves destroy worms.

BRAMAH'S PRESSING MACHINE, or Hydrostatic Press, is the highest power known to art, and founded on the very trite principle that the pressure of water is as the capacity of the volume pressed to the capacity or weight of the pressure. The hydrostatic paradox is the pressure as per heighth, but for heighth he substituted artificial pressure on a small column of water, flowing into a large one; and this is found equivalent to heighth. Hence, by pressing, with the force of 56 lbs., the water in a quarter-inch bore into a cylinder beneath a piston of 12-inch bore the power is $\frac{14 \cdot 4}{0 \cdot 06} \times 56$ lbs. $= 1200$ tons. The pressure is effected by a small lever, acting on a piston, and may be several hundred weights, if desirable. Or, instead of water, condensed air may be applied with equal force. These machines are now in general use by packers, pressers, printers, &c. and have been used with effect in tearing up trees, piles, &c. &c. Those for current use cost from 60*l*. to 150*l*.

BRAMBLE, (*rubus cæsius*,) possesses several properties, which deserve attention. Its roots, when dried in the shade, cut into small fragments, and, taken in the shape of a weak infusion, form a specific against obstinate coughs.

*Wine from the Bramble.*—Five measures of the ripe fruit, with one of honey, and six of water, boiled, strained, and left to ferment, then boiled again and put in casks to ferment, produce excellent wine.

BRANDY, or SPIRIT OF WINE, is a distillation from high-coloured white, or pale red wine, and is one of the staple manufactures of the South of Europe.

French brandy is perfectly colourless, and so sold in France. The colour is either communicated by mixture or by the cask. The mixture is either derived from oak shavings, or from catechu, or burnt sugar, or from charcoal and rice, digested in malt spirit. French brandies are commonly distilled from weak or unsaleable wines, and much from wine-lees, as the stalks, skins, and kernels, to which the skins give a peculiar flavour and afford an acrid oil. It is hence inferred by Aubergier that the various flavours of spirits arise from the fat oil, in the skins of the fruit and grain, and that, if skinned, all their spirits would afford the same flavour.

The body of the still is 3-4ths filled, the head fitted to the body and worm, and the joints closed. The fire is brought on quick, till the first spirit begins to distil, when it is slackened, and kept at an equal degree. The liquor that runs from the worm is assayed either by the hydrometer, by observing the bead, or throwing it on the still head, and applying a candle to it. When the vapour ceases to take fire, a fresh can is applied to the worm, and the *eau de vie seconde* is collected separately; but, for home use, the seconds are allowed to mix with the first portion.

The liquor that remains is called *vinasse;* and, being drawn off, a fresh portion of wine is poured into the still, and the distillation continued till all the wine is consumed. When superior strength is required, the brandy is re-distilled, and three quarters of it drawn over in the common still, with a gentle heat, so that the thread from the worm may be extremely fine; and the spirit is separated into different portions, as the strongest spirit comes over first.

When first distilled, it is as clear as water; and if preserved in earthen or glass vessels, keeps its colour; but in oak casks it becomes coloured.

925 lbs. of wine consume in distillation 60 lbs. of pit-coal, and produce, in 5 hours 42 minutes, 87 lbs. of *eau de vie preuve de Hollande*, and in 2 hours more, 98 lbs. of *repasses*.

Modern improvements are founded on the principle that wine consists of a mixture of water and alcohol, which ingredients differ in the temperature at which their vapours condense into a liquid. The condensing part of the distilling apparatus being, therefore, divided into two portions, and that next the still body kept at the temperature at which the vapour of water condenses, it becomes a liquid, and is made to flow back into the body, while the vapour of the alcohol, not being condensible by this temperature, passes on to the second portion of the condensing apparatus, which is kept at a lower temperature, and here it is also condensed and made to flow out into the receiver.

Six cwt. of wine distilled in the stills of Argand, and in stills constructed upon Chaptal's principle, yield, in nine hours, from 1-5th to 1-3d their weight in brandy, *à preuve de Hollande*. But in nine hours Solimani's apparatus converted 105 cwt. of wine into 1-6th its weight of spirit at 3-6, with 3 cwt. of fuel. So that in an equal time, and with 2-3ds the fuel, Solimani distilled 18 times as much wine into strong spirit as the best common stills could convert into ordinary brandy.

It owes this advantage to the flat form of the *dephlegmator*, which exposes a thin sheet of vapour, in a horizontal position, to the cooling action of the water. A *dephlegmator* of four sheets of copper, only 18 inches square, placed so close as to be but 26 inches high, rectifies, in 16 hours, 600 veltes, $17\frac{1}{2}$ lbs. each, of brandy into strong spirit.

*Cogniac*, is obtained by distilling the palest white wines in the ordinary still by a gentle heat, so as to avoid raising the essential oil contained in the skin of the grape. It is also obtained by distilling other white wines, or even the paler red wines, by Solimani's apparatus.

*Eau de Vie de Marc*, is known by the fiery taste of the essential oil of the grape with which it is imbued. It sells for 25 or 30 per cent. less than ordinary brandy. It is drank by the lower classes in France, and preferred by the English and the northern nations. It is made by distilling the dark red wines of Portugal, Spain, and other countries; or from the lees deposited by wine in keeping, the scrapings of wine-casks, the skins or grains of common raisins deposited in the making of raisin wine, the cake left in pressing grapes, and from the lees left in making vinegar.

The cake left on pressing grapes is prepared for distillation by being broken to pieces, and thrown into large covered tubs of water. The mixture soon ferments, and when complete, the liquor is distilled in the ordinary stills. In some places, the grape cake is broken, put into pits, and covered with earth; fermentation arises, and when ready, it is taken out of the pits, mixed with water, and distilled.

Brandy is coloured with burnt sugar, Saunders' wood, &c. It may be produced from all fermented liquors, but that from wine is generally preferred.

*British Brandy*, is a compound of 20 gallons of rectified spirit, 5 oz. of sweet spirit of nitre, 5 oz. of powdered cassia-buds, mixed with 5 of almond-meal, ½ oz. of sliced orris-root, and 20 prune-stones, stirred together occasionally for three or four days. Then add 3 pints of the best vinegar, and 3 of French brandy, and bung or bottle for use.

*Home Brandy.*—Take 20 pints of fully ripe gooseberries, and 20 pints of white or red currants; bruise them, and mix with 20 pints of soft water, and 2 galls. of port wine. Put these ingredients into any open vessel to ferment for a fortnight; then put the mixture through a press, or cloth of any kind, that will exclude the refuse. Distil this liquid twice, and you will have the brandy colourless. From every 20 pints of the mixture you may draw 10 pints of good brandy. To colour it, brown sugar, burned, may be used.—*Cal. Hort. Soc.*

*Brandy Bitters.*—In 6 galls. of proof spirit, and 5 galls. of water, infuse 3 lbs. of gentian, 1 lb. of cardamoms, 2 lbs. of orange-peel, 8 oz. of cinnamon, and 2 oz. of cochineal.

BRASS.—Calamine is burnt or calcined in a kiln, or even made red-hot. It is then ground to powder, and sifted into the fineness of flour, and mixed with ground charcoal. About 7 lbs. are then put into a melting-pot, mixed with charcoal, and about 5 lbs. of bean-shot copper uppermost. This is let into a wind furnace, 8 feet deep, where it remains 11 hours. One furnace holds eight pots, disposed in a circle round a grate. It is then cast into plates or lumps. 45 lbs. of raw calamine produce 30 lbs. burnt or calcined.

On a small scale, fuse 4 lbs. of copper in an earthenware crucible, in a wind furnace, covering with some charcoal. Add 1 lb. of zinc, in fragments, and stir it with an iron rod.

Pale Bristol brass consists of two parts of copper and one of zinc; and some manufacturers use zinc, and its oxide for cementing with the copper.

Zinc is melted in an iron pot; and run through a ladle, with holes in it, into a tub of cold water, and granulated so as to fit it for making brass. About 54 lbs. of copper bean-shot, 10 of calcined calamine, ground fine, and a bushel of ground charcoal, are then mixed together. A handful is put into a casting-pot, and upon it 3 lbs. of the grained zinc. The pot is then filled up with the mixture; and, in the same manner, other pots. They are then put into a wind-furnace, and about 12 hours complete the process. It is superior to the brass made from copper calamine.

For *Dutch Brass.*—The crucibles are about 15 inches high, and an inch and a half thick. The furnaces in which the copper is smelted are similar to the brass furnaces of England, and their mouth is upon a level with the floor. A deep trough is made below the pavement, to serve as a gallery to support the grate, and admit a current of air to the ash-pit. Into each crucible is introduced 40 lbs. of copper broken small, 65 lbs. of calamine in powder, and double its measure of charcoal in powder. After 12 hours, the scum and charcoal is skimmed off, and each crucible is thrown upon a bed of sand, in which the metal runs. This is called *arcost*, and must be subjected to a second fusion, with three handfuls of the mixture of charcoal and calamine. Over this is placed two or three lbs. of brass clippings; and then two handfuls of the first mixture are introduced, with a lb. of arcost and more of the mixture. The crucibles are placed in the furnaces for two hours, and then cast into plates, with the aid of two blocks of hard granite. It consists of four parts of copper and one of zinc, and may be hammered into leaves about 1-60,000th of an inch thick. It is this which is sold under the name of Dutch gold or Dutch metal: and used for gilding; but it requires the protection of varnish to prevent its tarnishing.

Some alloys of copper with zinc are known by the name of *Prince Rupert's Metal*, *Pinchbeck*, or *Tombac*, and made by adding a lb. of zinc to from 3 to 10 lbs. of copper.

Statue-founders use an alloy of 914 of copper, 55 of spelter or zinc, 17 of tin, and 14 of lead. Others use 824 copper, 103 zinc, 41 tin, and 31 lead.

The principal objects, in alloying copper with tin, is, to render the copper less oxydable to give hardness, to render it sonorous, more fusible, of close texture, and less tough and dingy.

Alloyed with one of the smaller proportions of tin, the metal is made of which cannon (brass guns) are made. It contains one part tin to nine copper. If more tin were added, the gun would fracture by the explosion, and, if less, it would bend.

Brass is preferred for kitchen mortars, and the skillets in which starch or milk is boiled.

As 2 atoms of zinc are equal to 1 of copper, alloys should be made in these proportions, whatever be the multiples of either. So as 1·19717 of copper is equal to 1 of tin, multiples of these proportions must be taken for legitimate alloys, *i. e.* 160 copper to every 147 of tin.

For colouring glass, brass is calcined three times, and, according to the proportions, it affords three shades of fine greens. With sulphur, it makes red or yellow. Exposure of these plates, in glass furnaces, also produces red powder.

Brass also makes bright colours for busts, &c. by filing bright sorts, and mixing with varnish, for gold colour; and, by mixing with red ochre and varnish, for red bronze. *Or*, Dutch brass, in powder, with a varnish, 10 spirits of wine, 1 gum lac, and 1 sandarac, makes a beautiful bronze, if used as soon as mixed.

BRAZIL NUTS, grow in cases of 20, 30, or more, and are eaten in Brazil, and much used in making oil, in which they are very productive.

BRAZIL WOOD, affords a red dye, with alum and tartar. With acids it makes liquid carmine, and, when varnished, makes beautiful cabinet-work. The heart of the tree is small, though the bark displays great bulk. It is deeper as a solution of alcohol and volatile alkali, and with the former stains heated marble violet and chocolate. Alum precipitates from the aqueous solution a crimson, and acids change to yellow.

BREAD, is a preparation of the flour, or meal of grain for food. The inconvenience attending the use of the grain in its natural state, and, perhaps, the accidental observation, that, when bruised, and softened in water, it forms a paste, and, when dried again, a more compact mealy substance, led by degrees to the artificial preparation of bread. The grain was first bruised between stones, and, from the meal mixed with milk and water, a dry, tough, and indigestible paste was made into balls. After many attempts, or, perhaps accidentally, it was observed that, by bringing the paste into a state of fermentation, its tenacity is almost entirely destroyed, and the mass becomes bread, porous, agreeable to the taste, digestible, and, consequently healthy. Some old dough, called *leaven*, which, by a peculiar spirituous fermentation, has swelled up, become spongy, and acquired an acid and spirituous smell, is kneaded with the new dough, and produces, though in an inferior degree, a similar fermentation in the whole mass. The whole thus becomes spongy; a quantity of air or gas is developed, which, being prevented from escaping by the tenacity of the dough, heaves and swells it, and gives it a porous consistency. This is called the *working* of the dough.

In this state, the dough is put into an heated oven, where the air contained in it, and the spirituous substance, are still more expanded by heat, and increase the porosity of the bread, making it materially different from the unbaked dough. In England, flour is adulterated with many foreign substances, in order to make the bread whiter. Bread is now found wherever civilization has extended, and is made of wheat, rye, maize, barley, oats, spelt, &c.

*Unleavened bread*, is flour and water kneaded either by themselves or with eggs, butter, sugar, and some other articles, and exposed to heat, by which the dough is a very solid mass, and never cellular, spongy, or light.

*Leavened bread*, is flour and water mixed together, and left for some hours, so that the sugar in the flour may be fermented, or be changed into alcohol and carbonic acid gas, and by expansion render the bread spongy and light: or it has yeast added, which accelerates the fermentation.

Bread has been very aptly called the *staff of life;* it should be good,—that is, *light and sweet.* To make good bread, barm or yeast of good quality should be combined in due proportion with good flour. The grand secret, of having the bread come out of the oven delicious, and nutritive, is the exact point of time of putting it in. While in the dough, it runs into three sorts of fermentation, the *saccharine*, the *vinous*, and the *acetous.* If the dough be formed into loaves, and thrown into the oven before the first fermentation, the bread will turn out *heavy.* If it be kept from the oven till the second fermentation, it will prove to be light enough but *tasteless*, and if it be delayed till the acetous fermentation, it comes out sour, and uneatable. It is then, *during* the first, or sugar fermentation, that it should be put in the oven, and it will then, after well baking, come forth *sweet* and wholesome. Taken during the saccharine fermentation, it will have all the requisite lightness, while the sweetness is confined in the loaves. That it should be without sweetness, when allowed to run into the vinous fermentation, is not at all strange, when it is considered that sugar has turned into wine, or rather *spirit,* and the spirit has evaporated during the process of baking. It may be easily distinguished without tasting, by its loose open appearance, the pores or cells being very large; whereas, genuine good bread is marked by finer pores, and a sort of network of a uniform appearance.

For a small *family baking* of about two quartern loaves, take 6 lbs. of flour, rub in a spoonful of salt, and add to two-thirds of a pint of table-beer yeast, a quart of lukewarm water; which pour into a hole in the middle of the flour. Strew a handful of flour over it, and set it in a warm place. In half an hour it will ferment, and may then be well kneaded, adding water as necessary, and set to rise for half an hour. It is then to be shaped, and put into the oven for two hours. Any failure, by this simple means, to make good bread may arise from the yeast being stale or thin, or from the water being too hot or too cold, or from the heat of the oven not being well regulated. Tins make the handsomest loaves. Milk and water, instead of all water, is a further improvement.

*London bakers* dissolve, in 36 lbs. of warm water, from 4 to 6 lbs. of salt, at the temperature of 84°, and then add 3 pints of yeast: on the other hand, they make a hole in the midst of a heap of 280 lbs. of sifted flour, and with the solution of salt, and sufficient yeast for the flour, they make a paste sufficiently thick, and which they term a quarter sponge; they then again cover it with more flour, and close the kneading trough with a piece of flannel. Three hours afterwards, they add 360 lbs. of warmed water to it, and knead up the mass with a new quantity of flour; this they term half sponge; five hours afterwards, they again add 108 lbs. of hot water, and work it with the remainder of the flour, for an hour at least; they then cut it into bits, again cover it with flour, and leave it at rest in a corner of the trough. Four hours afterwards, they knead it for half an hour, and then form it into loaves, which they afterwards place in the oven. They judge when the oven is sufficiently hot, by throwing a pinch of flour into it, and which ought to become black instantly, but without taking fire; they place the loaves so near to each other in the oven, that, when they rise, they press each other, and take the form of cubes. They leave them two hours and a half in the oven, and when they withdraw them, they take care to cover them, to prevent them as much as possible from losing their weight. The loss, from the baking, amounts to a ninth part of the total weight, and yet the loaves nevertheless become three times as large as when put into the oven.

*French bakers* commence their operations at 5 o'clock in the morning, by mixing 5 pints of water, and 3 lbs. of leaven, reserved from the last baking, and as much flour as will make a paste weighing 17 lbs. Ten hours afterwards they add 10 or 11 pints more water, and sufficient flour to make a paste of 40 lbs. weight; two hours afterwards, 24 pints more water, and flour enough to make a paste of the weight of 120 lbs. From this paste they cut off a portion of 3 lbs. in weight, to serve for the leaven of the next day's baking. Then, 4 hours afterwards, they make a new addition of 100 lbs. of flour, and from 70 to 80 pints of water, and which will yield a mass of about 300 lbs. weight. They then begin to beat the paste, and when it is well kneaded, they separate about 80 lbs. of it, which is to serve as the leaven for the next baking. This paste is so fluid, that the loaves cannot preserve their form before they have been exposed to the heat of the oven. For the second baking, after having mixed the quantity of flour necessary, by kneading it, they add the paste reserved from the former baking, and, when the mass is finished, they cut off a part weighing 80 lbs., and thus they proceed a third time, a fourth, and so on, until they have made twelve bakings. They thus continue to work for several days together, only they modify it after every fourth baking, by adding what they term a young leaven to the paste which each baking had impaired or weakened. If they would introduce into the paste either salt or yeast; they thin it in a proper manner with water, which contains yeast or salt in solution. They also use yeast for the soft bread. A quarter of a pound of the yeast from beer is equal to 8 lbs. of the paste leaven; so that 4 ozs. of yeast are equivalent to 20 lbs. of the paste. The paste in which they have mixed the yeast must not, however, be mixed with that containing leaven.

The goodness of bread depends upon the mode of kneading; much air is introduced into the dough, if the closed hands are slid under the mass, and then opened, bringing a quantity of the dough from the bottom, and dashing it to the other end four, five, six, or even eight or ten times. On the other hand, pressing the dough generates sugar alone, and this method is used for biscuits. The imperfect kneading of home-made bread by pounding the dough with the fist, is the cause of its sweetness and superiority.

*Bread machinery.* Mr. Cawderoy has patented improvements in machinery, to be used in the process of manufacturing bread and biscuits. This patentee has devoted his attention to every part of the process of bread manufacture; he commences the operation by causing the flour to pass through a sieve, by means of a cylindrical brush, in very minute quantities, and with much uniformity. From this sieve, the flour descends into a mixing vessel with an inclined bottom. The liquid to be mixed with the flour, to constitute the sponge, is admitted from a reservoir through a pipe near the bottom of the mixing vessel, and the quantity admitted during the process is adjusted to the quantity of flour passed through the sieve, by means of a stop-cock. On the inclined bottom of this vessel, a series of vertical rods, constituting a kind of rake, is made by means of a crank, to move forwards and backwards on the inclined bottom, in a direction at right angles to the inclination; and the apparatus is so arranged, that the quantity of inclination may be varied at pleasure, to suit different qualities of the bread intended, or of the materials employed in its manufacture. The greater the inclination, of course, the quicker will the mixture pass off from the rake into the second mixing vessel, placed a little lower than the first, to receive it. This vessel, which has its bottom horizontal, is likewise furnished with a traversing rake, to mix the ingredients still more intimately. The sponge is afterwards returned into the mixing vessels, to have an additional supply of materials to complete the dough, the usual time being allowed for it to rise and fall, to prepare it for separation into loaves, and the operation of baking. The dough is next transferred to a pressing vessel, through an aperture at the bottom of which it is forced, by means of a piston, into a long trough, where it is separated into loaves, by means of a frame furnished with projections of the size of the intended loaves. The frame descends till the dividing partitions cut half through the dough in the trough. The dough is then turned by means of the trough frame, in which it is held swinging on two pivots, and the dividing frame is brought down again, to complete the separation of the loaves.

The loaves are then conveyed into an oven on a stage mounted on rollers, and furnished with an endless band of cloth, or other suitable material, by the motion of which they are delivered in succession from the stage upon the oven floor; and when the baking is completed, this stage, with its endless band, is forced into the oven under the loaves, and brings them all out at one time. And thus will be obtained a much greater uniformity of baking than can be effected by the usual method of filling and emptying the oven.

*Household bread* is now seldom made by public bakers, but usually by families. As brown flour retains more water, after baking, than white, this bread keeps moist longer than white, but the middle crumbles. Deficient kneading gives it a sweet taste. As brick or stone ovens are seldom kept in heat in private houses, the bread is imperfectly baked, and loaded with superfluous water. It is, therefore, preferable for small families to bake in an iron oven, 20 inches from front to back, 16 inches wide, and as many high; this will bake 20 lbs. of bread in two hours.

Other ovens are fixed on one side of the kitchen range, so that a sufficient degree of heat is communicated to the oven without trouble.

15 lbs. of good wheaten flour ought not to absorb above 10 lbs. of water in dough, which should produce about 20 lbs. of bread.

A quarter of wheat of 8 bushels, or 2 sacks, yields from the miller

| | *Bushels.* |
|---|---|
| Fine flour ...... | 5·75 |
| Seconds ......... | 0·00 |
| Fine middlings .. | 0·25 |
| Coarse do. ...... | 0·125 |
| Bran ........... | 3·0 |
| Twenty-penny .. | 3·0 |
| Pollard ......... | 2·0 |
| Bushels ....... | 14·625 |

In other respects 16 ozs. of wheat consists of 3 bran, 10 starch, gluten and sugar 1.

The wheaten (w) is made of the fine flour, the standard wheaten (s. w.) is the whole mixed flour, or 4 first sorts. The flour hold is the 2d, 3d, and 4th.

A peck loaf, which, for sale, weighs 17 lbs. 6 ozs. was 19 lbs. 12 ozs. when put into the oven, so that there is a loss of weight by baking of 2 lbs. 6 ozs. or 79 to 69·5, or 8 to 7 nearly, or one-eighth.

French bread loses a 6th, owing to its long form.

The sack of flour of 5 bushels weighs 280 lbs. and makes 80 quartern loaves, each weighing 4 lbs. 5 ozs. 8 drs. and the whole 347 lbs. 8 ozs. when baked. Hence the increase for salt and water is 67 lbs. 8 ozs. Good flour and old flour absorb more water, and will produce 83 or 84 loaves.

If flour is new, after a wet season, carbonate of ammonia, of a pure quality, dissolved in warm water, and introduced into the dough when stiff, will remove unpleasant effects, and make the bread quite light, (1 oz. to 14 lbs. of flour.) The weight of bread is considerably increased, by using bran-water in kneading the dough. 3 lbs. of bran, boiled for an hour, for 28 lbs. of flour.

To make good bread from damaged flour, the mealmen sell to the bakers an article called *sharp whites* to mix.

and it consists of flour mixed with a high proportion of alum. They also have a mixture called *stuff*, sold as salt, but composed of 1 alum and 3 salt.

When bread is made without alum, it is necessary to bake it in tins, to prevent the adhesion of the loaves.

Pea-flour, potatoe-flour, and bean-flour, with gypsum, chalk, whiting, and bone-ashes, are also mixed with bread, by many dishonest mealmen, millers, and bakers.

Alum and spirits of vitriol are used as binders and whiteners of the bread.

Salep improves bread, and increases its quantity, if used in the proportion of an oz. to a quart of water.

The weight of bread is increased by boiling, for example, 5 lbs. of bran in 4 galls. of water, so as to strain $3\frac{3}{4}$ galls. And 56 lbs. of flour, made into bread with this water, is said to produce 83 lbs. of bread, while the same weight of flour with plain water produces only $69\frac{1}{2}$ lbs.

*Ovens* are circular, from 3 to 12 feet in diameter, and the crown from 2 to 3 feet. When the oven must be kept hot during the day, the heat is maintained by a fire-place on one side, a little below the level of the floor of the oven, whence a flue passes under the oven floor, and round the sides.

To introduce *potatoes* into wheaten bread:—Boil 5 lbs. of potatoes well, then dry them over a fire, or in the oven, until they fall to pieces and become flour; then make of them a batter, of the consistency of thick gruel, strain this through a coarse sieve or cullender, and mix this, instead of water, with 20 lbs. of flour. If the yeast be good, the bread thus made will be as light and agreeable as all flour.

Pulp of potatoes, mixed with flour, makes good bread, 16 lbs. of raw potatoes boiled, peeled, pulped, and kneaded with 26 lbs. of flour, produce 40 lbs. of bread.

Biscuits, are made of fine stiff dough, beaten or rolled out on a dresser, with a mallet, or roller, and the doubling repeated several times. Common sea biscuits are made of pollard. The dough is made up very stiff, without either yeast or salt, and as it extends on being trod upon the floor, or is beaten on a table, the edges are cut off with a spade, replaced upon the mass, and again trod or beaten, to render it flakey. The baking is performed in very low arched ovens, 20 ft. in length, or more, open at both ends, and heated by flues, by a fire at each end. The biscuits, previously pricked, are put in on iron plates, connected by hooks and rings, or to an endless chain. The plates, as fast as they are filled, are drawn through the oven, and by the time they arrive at the other end they are fit for use.

French sea biscuit is made by adding to 100 lbs. of flour 10 lbs. of leaven, older than that used for bread, and sufficient hot water to form a stiff dough, to be kneaded by the feet; or add to the flour half its weight of new leaven, and make the dough thinner, so that it may be kneaded by the hands.

The oven is heated less than for bread, and takes two hours.

The mere mixture of flour and water enters into *fermentation*, but 4 ozs. of flour, with a pint of water, kept at 70°, take four days to ferment. Salt, or carbonic acid gas, do not impede or promote. 8 ozs. of flour and 2 pints of warm water begin to rise on the second day, and by adding 1 lb. of flour and 4 pints of water for a day or two, an original fermentation may be obtained, which, added to a fresh mixture of flour and water, for bread, will produce a fermentation of the whole within four hours.

This ferment having been so obtained, the fermentation of another batch of bread is excited, by reserving some of the fermented dough, and mixing it. This reserved dough is called leaven, and for a next week's, or month's baking, may be kept for use if buried in a sack of flour; or, it may be kept in a warm place, between two bowls, and every day as much flour added as the leaven weighs, with sufficient water for consistence; or, the scrapings of the kneading dough, may be cut into small pieces, dried gently, and, when wanted, rubbed down with warm water as a ferment.

But the scum that arises in the fermentation of malt liquors, called yeast or barm, is generally preferred, in the proportion of 1 quart to a bushel of flour, and it produces fermentation quicker than leaven. It is dissolved in the first parcel of water with which the flour is mixed, but, in France, the dough is still made with leaven, and some yeast added to the last water, to increase the sponginess.

Original yeast may be obtained by boiling a quarter of a peck, $3\frac{1}{2}$ lbs. of malt, for ten minutes, in 3 pints of water, pouring off 2 pints, and keeping in a warm place about 30 hours. Four pints of a similar decoction of malt are then added, and after this ferments, other four pints are added, until sufficient yeast is made.

*Levure*, is the bottoms of the working tun and store casks. The beer is drained from it through sacks, and the solid matter left in the sacks is dried. Even true yeast is drained and dried in the same manner, and Paris bakers always prefer it in a solid state. It is yellow, or greyish white, and breaks with a smooth surface.

To multiply yeast, mix 10 lbs. of flour with 2 galls. of boiling water, and cover it up for 8 hours, then stir in two pints of yeast, made the day before, and in 6 or 8 hours yeast is generated for $1\frac{1}{2}$ sack of flour.

A similar ferment for all the year is also made by boiling wheat bran in water with hops. The decoction soon ferments, and bran is added to absorb up all the liquid. This is formed into balls, which are dried in a gentle heat. Boiling water poured upon them is then used to make up the dough.

When yeast, leaven, or dough, turn sour, so as to give a sour taste to bread, stir in a few tea-spoonfuls of magnesia.

When the yeast is bitter, mix with it some bran, add some warm water, let it stand for two or three hours, and then strain it.

When the baker has not dough for sudden demand, it may be made by dissolving, for every 4 lbs. of flour, $1\frac{1}{2}$ oz. of sub-carbonate of ammonia in the water. This, well kneaded, may be baked immediately, and it produces bread which is porous, with the numerous cells, with a slight tinge of yellow.

As white flour absorbs less water than brown, so white bread is more economical than the brown; and the weekly expenditure for bread is less, for the best white bread, than when cheap bread or brown bread is used.

*Bread without yeast*:—Mix 2 lbs. of mashed potatoes with 2 table-spoonsful of porter, 2 table-spoonsful of flour, and a table-spoonful of salt; beat these ingredients well together, adding as much lukewarm water as will reduce the composition to the consistency of butter. Let it stand for 24 hours, in a closely-covered earthenware jar, when it will be fit for use. For every lb. of flour to be baked, take four table-spoonsful of the composition; mix up two-thirds of the flour, adding a little lukewarm water, or fresh cream, then knead the remainder of the flour into the mass of dough; give it the desired shape, and let it stand 4 hours covered with a large dish, before it is put into the oven. Replace the composition, by an equal quantity of mashed potatoes, flour, and salt, in the proportions stated above; and beat the whole together in the jar, having first poured off the liquid collected at the bottom of the vessel. Let the jar be kept well covered, in a warm place, in winter.

BREAD-FRUIT TREE, *(Artocarpus incisa.)* A tree producing a fruit, which, without any preparation, has the appearance of, and is used as a substitute for, *bread*, from the time of DAMPIER, who appears to have first made known the existence of such a plant to Europeans, it has been spoken of as one of the wonders of the vegetable creation. Dampier saw the tree abundantly in the Ladrone Islands, and he tells us that the fruit is as big as a penny-loaf, when wheat is at 5*s*. the bushel; that the natives of Guam use it as bread, "gathering it when fully grown, while it is green and hard, and then baking it in an oven, which scorches the rind and makes it black; but they scrape off the outside black crust, and there remains a tender, thin crust, and the inside is soft, tender, and white, resembling the crumb of a loaf. There is neither seed nor stone in the inside, but all is of a pure substance, like bread. It must be eaten new; for if it is kept above 24 hours, it becomes hard and choaky, but it is very pleasant before it is too stale. The fruit lasts in season 8 months in the year, during which, the natives eat no other sort of fruit." Above forty years afterwards, ANSON, in visiting the same islands, speaks of it as being equal in size to a *two-penny* loaf; and he compares the flavour, when boiled or roasted, to that of the common potatoe; and further tells us, that "the Spaniards slice it, and expose it to the sun, and when brought thereby to crispature, they reserve it as a biscuit, and say it will bear long-keeping when so prepared. Eaten ripe, it is delicious to the palate; and when mixed with lime or orange juice, it makes a grateful tart not unlike to apple-sauce. It was eagerly sought by the crew of Commodore Anson, and preferred by them to bread." But it is in the South Sea Islands, that the best *bread-fruit* is found. Captain COOK says, that the flavour is insipid, with a slight sweetness, somewhat resembling that of the crumb of wheaten bread, mixed with Jerusalem artichoke. From Otaheite, then, it was arranged by our government, that the tree should be imported to the West Indies. 1150 *bread-fruit-trees* were embarked, and 550 were landed at St. Vincent's, in January, 1793; the rest went to Jamaica, with the exception of 5 plants, for the garden at Kew. In St. Vincent's the *trees* began to bear in the following year, and it has thence been communicated to the other islands, and to the colonies of equinoctial America. It is, however, not probable that its cultivation will ever supersede that of the *Plantain*, and its several varieties; which, on the same space of ground, furnishes more nutritive matter. The negro, forgetting that for three parts of the year the *bread-fruit-tree* is loaded with ripe, or lately developed fruit, considers only the greater rapidity with which he may reap the produce of his plantain, which, in a few months after the setting of the sucker, repays the owner's pains.

The bread-fruit rarely exceeds 8 inc. in diameter. When ripe, the skin assumes a yellow crust, and the juice, exuding in tears, runs down its sides, and is concreted by the sun. It is eaten plainly boiled as potatoes, as a substitute for bread; it is baked after the central pith has been removed, and it is often made into boiled or baked puddings.

There are many varieties of the bread-fruit:—

1. Round and rough (muricated) fruit.
2. Oval and rough, one of the most valuable.
3. Oval and smooth variety; the second-best.
4. Round and smooth variety.
5. Timor variety: small, and very inferior.

In its native countries, clothes are made of the fibres of the *liber* or inner *bark*; the *wood* serves for building houses and making boats: the *male catkins* are employed as tinder; the *leaves* for wrapping provisions in; and the viscid milky *juice* affords birdlime. It exists in a living state in the Glasgow, and other botanic hot-houses of this country, but it is imported and kept alive with great difficulty.—*Curtis's Botanical Mag.*

Bread, st. john's.—This tree is of great importance on account of its fruit, which grows in pods. In Valencia, one tree will sometimes yield a crop worth 3 or 4*l*. It is generally used for feeding horses, but also as human food, and to adulterate coffee and cocoa.

BREAKWATER, is any massive obstruction to the course of the tide or current into a harbour. Sometimes the effect is produced by a pier, as at Margate, Ramsgate, &c.; and at other times by a wall of stones, secured by iron cramps, or timbers, as at Cherburg, Plymouth, &c. It is merely an idea carried into execution by massive and coarse work. Stones from 1 ton to 8 tons each have been sunk in the Plymouth one, amounting to above a million of tons, at a cost of a million and a half sterling, and with perfect success.

BREAST-WHEEL; a water-wheel which receives the water at about half its height, or at the level of its axis. Float-boards are employed, which are fitted accurately to the mill-course, so that the water, after acting on the floats by its impulse, is detained in the course, and acts by its weight.

BREEDING, the art of improving live stock and animals. As the lungs are the prime movers of the animal machine, breadth of chest is essential, for external form indicates the internal. Strength depends on the size of the muscles. Rapid growth and early maturity depend on food feeding. The sex depends more on the female than the male. Two cows, whose bull was changed every year, had 14 cow-calves running. Soft skins indicate a disposition to fatten. Breeding, *in and in*, in the same family, creates small bones, much fat, and great listlessness; but, after a few generations, the females cease to breed and the males to beget, or the breed becomes small, stupid, and short-lived. The rule is, that best can only beget best. Even in vegetable seed, the *in and in* system fails as much as in royal and aristocratic races. In continuing a cross-breed the male should still be of the first breed. The female, in crossing, should be larger than the usual size. Small males and large females alone improve the breed. Fleece depends on the male. Cows breed best in three years. Bulls have full vigour at two and improve till eight. The male decides the breed more than the female. The legs are mostly like the female, but the carcase like the male. The strongest males, in all animals, are those whose nature has fitted them for propagation; and this is decided by breadth of chest and back, and fullness of muscles. The system of enlarging breeds seems now to be exploded, and the perfect middle size to be preferred.

The Bakewell system of *breeding* in and in, which enlarged the carcase, but destroyed the vigour, is now exploded; and the best breeders avoid consanguinity. When the female is too small and the male too large, the offspring is ill-shaped. Breeding in consanguinity not only deteriorates the intellect but shortens the lives of offspring. It is this which has destroyed all the families of the English nobility, and, at the same time, has so lowered their intellects; and this is more especially the fact, in royal races, where an absurd and brutal pride prevents any crossing.

In breeding, a greater number of one sex than of the other may be obtained, it is said, at the option of the breeder. The principle is, that when most males are wanted, the power of the male parents should be increased relatively to the strength of the females; and when most females are wanted, the contrary. The farmer wishing a great number of female lambs, is recommended to put very young rams to the ewes: and during the season that the rams are with the ewes, the ewes should have more abundant pasture than the rams. When male lambs are chiefly to be obtained, strong and vigorous rams, four or five years old, are to be put to the ewes.

BREWING, extracting the juices of fruits, containing sugar, or the saccharine principle, which is essential to the vinous fermentation. In seeds, we have starch, and this may combine with water, so as to form sugar. This combination is known by the name of *germination* or *growing*, and takes place in every seed that is successfully planted. The seeds of wheat, rye, barley, &c. consist principally of starch, and if a grain of these is examined, we find near one end of it a small body, the rudiment of the future plant, and the microscope shows us that this consists of two parts—the *plumula*, which is destined to ascend through the earth to form the stalk, and the *radicle*, which is to be spread abroad below, and form the root. Whenever a grain of barley, oats, or certain other of the graminiverous seeds, is put into water, it begins to swell and absorb the moisture; and, at the same time, if the temperature of the air is not too cold, the radicle thrusts itself out at the lower end; the plumula, on the other hand, pushes itself along beneath the husk of the grain to the other end, before it thrusts itself out. The plumula, in passing along through the husk, changes the part of the seed along which it passes into the substance known in chemistry by the name of *starch-sugar;* that is, when the plumula has passed along one-third of the length of the grain, that third is starch sugar, while the remaining two-thirds are still starch. The starch-sugar seems to be a combination of starch and water. The final cause of the change is the support of the growing plant, sugar being necessary to the growth of plants, as it is always found in their sap, and sometimes in great quantities. The moment, in which the plumula begins to protrude beyond the end of the grain, the sugar diminishes, as it is consumed by the young stalk; and the substance of the seed is also consumed, though by no means to the same extent, by the growth of the root.

To produce these changes in seeds, and thereby fit them for yielding a sweet fluid, when mixed with water, is the business of *the maltster;* and it is an operation of great delicacy, upon the successful performance of which the manufacture of good ale or beer in a great measure depends. The first operation, in malting, is, to plunge the barley, or other grain, to be malted, into a large cistern, containing water enough to cover the whole mass. The barley immediately separates into two parts; one is heavy, and remains at the bottom of the water, while the lighter portion, consisting of chaff, defective grains, &c. float on the top, and is of no use. The heavier part, or sound barley, is suffered to remain till it has absorbed a portion of the water, sufficient to enable it to germinate. This is called *steeping.* It is the first process, and usually occupies about two days.

When the grain is sufficiently steeped, the water is let off, and the grain thrown out of the cistern, and piled in a heap or *couch.* After a few hours, the bottom and inner part of the heap begin to grow warm, and the radicle, or root, to make its appearance; and the germination thus commenced would go on rapidly but for the active interference of the maltster, who, with a view of making all the grains grow alike, checks the growth of such as are in the middle of the heap, by turning them to the outside. For this reason, malting cannot be performed, with any success, in summer, and the best maltsters prefer the coldest weather; for, at this season, they can always keep the germination at the rate they wish, by heaping up the grain; whereas, in warm weather, it grows so rapidly, that no effort can keep the process equal and regular.

Thus the grain is turned backwards and forwards for 14 days, at the end of which period the *acrospire*, as it is called, or the plumula, having nearly reached the end of the grain, and the latter having acquired a general sweet taste, the process of growth is suddenly and effectually stopped by spreading the whole upon a kiln, which is a floor of iron or tiles, perforated with small holes, and having a fire beneath it. There the life of the plumula is destroyed, and the grain is thoroughly dried.

The malt thus made is crushed, by passing it between a pair of iron rollers, and it is then prepared for *brewing.*

The first step in brewing is called *mashing.* It consists in stirring up the malt with a quantity of hot water, which dissolves the starch-sugar of the malt, and forms a sweet liquor called *wort*, similar to the must, or sweet juice of the grape, from which wine is made. The manufacture differs, however, in some essential particulars, at this stage of the process, from that of wine; for, if the wort were allowed, as the must is, to ferment without obstruction, it contains so much of the mucilage and starch of the grain, that it would run into the acetous, and from thence into the putrefactive fermentation, and would be *foxed*, or become ill-smelling vinegar instead of beer.

To prevent this, it is boiled; and this process renders it stronger, by evaporating a portion of the water; and, further, it coagulates or curdles the *mucilage*, which subsides afterwards, and is not again dissolved. When boiling, a portion of hops is added, to check the tendency to the acetous fermentation, which is always far greater, in liquor so compound in its character as beer, than in wine and cider.

After the worts are sufficiently boiled, they are poured into coolers, till they become cool, and deposit much of the curdled mucilage. They are then run into a deep tub or vat to ferment. If left to themselves, however, the process would take place very imperfectly, and it is therefore assisted by yeast, which excites fermentation for a period of time longer or shorter, according to the wish of the brewer, and is finally checked by drawing off the liquor into barrels or hogsheads; the fermentation in which is called *cleansing*. The casks are placed with their bung-holes a little to one side, and the scum, or yeast, as it rises, works out, and thus the beer is cleansed from a quantity of mucilage, &c. What does not run out subsides to the bottom, and constitutes the *lees*. After this, the clear beer is sometimes racked off into barrels, hopped and preserved for use. The yeast is collected and used in the next brewing. Some starch and gluten still remain, of course, and the liquor soon begins to ferment again in the barrels; but, as these are closely stopped, the carbonic acid gas cannot escape, but incorporates with the beer. By repeated racking, the fermentative matter may be completely removed, and such beers become clear, transparent, and, by being bottled, remain for years without *coming up*, as it is technically called. The object of the brewer is to produce an agreeable beverage, distinguished not so much for absolute strength, or quantity of alcohol, as for colour, flavour, transparency, liveliness, and power of keeping for a long time.

All are comprehended under 3 principal names—*beer*, *ale*, and *porter*. It is of no consequence, so far as regards the principle of brewing beer, whether the malt of which it is made be of one colour or another: it may be pale, or highly-dried, or amber, or any other colour. Moreover, it is a common practice of brewers to colour it so highly with burned molasses or sugar, that the original taste of the liquor is, in a great measure, concealed. There is also a sort of fulness of taste given to beer, by this practice in part, but still more by the mode of fermentation. This mode is to stop the progress of the latter before the sweet taste is entirely gone, by removing the beer earlier from the fermenting tun to the smaller casks. But when beer is sent out in this state, it is always necessary to mingle with it a quantity of what are called *finings*, that is to say, isinglass, or something of the sort, which carries the dregs to the bottom.

Ale is sweeter than porter, and likewise much stronger; the best brown stout being about 25 per cent. weaker than Burton ale. The first part of the process, on which the difference in the liquors depends, is the drying of the malt; for ale, it must be dried very carefully and slowly, so as to be of a pale colour; and the article is inferior, if any of the grains are scorched or burned, so as to communicate a harsh taste to the liquor. In the next place, the heat of the water, poured on the grain in the mash, is higher, or from 180° to 190°. In the next place, the mashing must not be long continued, as it is only desirable to dissolve the sugar; and the effect of long mashing is to mix the starch and mucilage with the worts, and, of course, to diminish their comparative sweetness. For the same reason, the first mash only is proper for fine ales, as the last always contains much more starch and mucilage. These ales thus acquire a sweetness which cannot be removed, except by very long fermentation, and, therefore, they continue palatable longer than porter. They are then drawn off clear from the tun, and filled up in the casks, and cleansed, till the yeast is as much as possible removed. Lastly, porter requires a large proportion of brown or high-dried malt; *i.e.* malt which has been scorched on the kiln; but it is rarely made so at the present day. It is a wasteful and expensive practice to dry malt in this way, as very much of its valuable constituents is wasted by high-drying. Only a small portion of such malt is, therefore, now used, the colour being produced artificially, by means of burned sugar. Low heats are used in the mashing, for the liquor is not to be sweet, and it is, therefore, most profitable to get as much starch as possible. For the same reason, the products of all the mashings are mingled together, thus constituting *entire* beer. Porter is fermented with more rapidity than ale, and hence it requires very careful watching, lest it suddenly pass the bounds of the vinous, and run into the acetous fermentation. It requires to be cleansed at a moment's warning, or else it gets acid. After all, it abounds in unfermented matter, and requires time to ripen, that is, to change this matter into alcohol; and this it does best in large masses. Colour is added to suit the taste of the consumers, who obstinately associate the idea of strength and body with high colour. But ales, to be perfect, must be pale, and fine ales always are so.

Worts are more likely to be clear when the water is 180° than more, but sometimes they are turbed throughout, and the beer requires fining. The saccharine matter comes away with the first wort. The last wort contains chiefly starch and mucilage.

In boiling, the quantity should be reduced 1-6th.

In Edinburgh, but 2-3ds of a lb. of hops is boiled in the wort, per bushel of malt; and a barrel of ale is produced from 5 bushels of malt and 3¼ lbs. of hops. When 7 bushels to the barrel, then from 6 to 7 lbs. of hops are boiled with the wort. The sp. gr. of the wort, after boiling, is 1·09 to 1·1; *i. e.* 10 lbs. of the wort are equal 11 of water.

Quick cooling is of consequence. The hotter it is when turned into the coolers, the more it loses and the sooner it falls to the atmospheric temperature. When set to cool, at 160 or 180, it cools, in a depth of three or four inches, in 11½ hours, and loses 1-13th; but, at nearly boiling heat, it cools in 8 or 9 hours, and loses a third or fourth. The temperature, when cool, is from 51 to 56.

In tunning, when cool, the yeast should be about three pints to a barrel of 36 gallons of ale, and it should be well mixed; but the quantity should vary with the quality of the yeast and the weather, much less being required in hot weather. The fermentation continues from 7 to 10 days, during which the heat increases from 12° to 20°, and the sp. gr. falls about 1-20th.

When the head begins to fall it is skimmed off; the liquor is put in casks; but if the fermentation is unduly stopt, the head should be very actively roused into it for a considerable time. The casks should be kept full, and the bung-holes inclined till the fermentation ceases. It is then well bunged for keeping and for use.

In steeping, to malt, barley swells from 100 to 183 and less. In steeping, it yields carbonic acid, and the husk partly dissolves. The steeping lasts four to five days. It is then formed into a square couch, where, in four days, it sweats and *germinates*. It is then kiln-dried, to destroy the germination, at a temperature increased from 90° to 150°, 180°, and even 200°.

100 lbs. of barley is thus reduced to 80 lbs. of malt. But if equally dried, without steeping, it would be put 88°; so that the loss is but 8 lbs. on 88, or 9 per cent.

The bulk of English barley is increased, by malting, from 100 to 105, or 110, or less. The sp. gr. of malt averages 1·201.

100 lbs. of malt, after brewing, afford dry grains equal to 50 or 51 lbs.; and 100 lbs. of raw grain, first malted and then brewed, yield 55 or 56 lbs. of grains.

In bruising malt for mashing, the most approved method is, use rollers, instead of grinding-stones, by which the husk is kept whole, and the starch merely broken inside.

Colouring for brewers is made by melting brown sugar till bitter, and adding lime-water, to make a syrup.

A mash-tun should be one half larger than the bulk of malt to be mashed in it.

Malt is tested, as to the goodness, by throwing a handful on water, and seeing what proportion does not sink.

Most of the operations in great breweries are now effected by the steam-engine, and continuous works. Mashing is performed by a rotative machine; pumps raise all the liquor, worts, &c. &c.; the pipes are made of caoutchouc, and art and science concur in conferring economy and perfection on the various processes. If drugs could be excluded, valuable, wholesome, and desirable products would be the result.

*Domestic Brewing* may be effected by boiling the water in a washing copper, or even a large tea-kettle, and drawing out the virtue of the malt in any clean pans or tubs about the house. Put one peck of barley or of oats into an oven just after baking, or into a frying-pan, just to steam off the moisture, and dry it well, but on no account to burn the grain; then grind or bruise it roughly. Boil 2½ gallons of water, and when it has stood 10 minutes (say at a heat of 175°, or so hot as to pain the finger sharply,) put in the grain; mash it well, and let it stand three hours; then drain it off. Boil 2 gallons more water, which pour on the grains, (rather hotter than before, but not boiling, say 196°) and mash them well, let it stand two hours and draw it off; mash the grains again well with two gallons more water, and in one hour and a half draw it off. The three worts will be about 5 gallons. Then mix 7 lbs. of treacle in 5 gallons of water, and boil the whole 10 gallons with 4 oz. of hops, for one hour and a half, taking care to stir it so long as the hops float on the top; let it cool, and when about milkwarm take a good teacupfull of yeast, and stir it well together, beginning with about a gallon of the wort at a time; let it ferment for 18 hours in a tub covered with a sack; put it into a nine-gallon cask, and keep it well filled; bung it up in three days, and in fourteen days it will be good sound fine beer, equal in strength to London porter. If you cannot get treacle, take 5 lbs. of the *cheapest* and *darkest sugar* you can get; this is better for your purpose than finer.

*Or*, mix 14 lbs. of treacle and 11 galls. of water well together, and boil them for two hours, with 6 oz. of hops; when quite cool, add a teacupful of yeast, and stir it well, by a gallon or two at a time; let it ferment for sixteen hours in a tub covered with a sack; then put it into a nine-gallon cask, and keep it well filled up; bung it down in two days, and in seven days it will be fit to drink, and will be stronger beer than London porter. This is the simplest, as it requires no skill—a washing copper or tea-kettle, and a tub, are the only requisites.

*Or*, boil 8 gallons of water, and when it has stood 10 minutes, (say 176°, or so hot as to pain the finger sharply,) put into it one bushel of ground malt; mash it well; let it stand for three hours, and draw it off; pour upon the grains 8 gallons more of boiled water, rather hotter than before, but not boiling, (say 196°) mash it, and let it stand two hours, and draw off; then mash the grains with 8 gallons more water; let it stand one hour and a half, and draw it off; mix 28 lbs. of treacle in 20 gallons of water, and boil the whole together with 2 lbs. of hops, for two hours, stirring it so long as the hops float; let it cool, and when about milk-warm, mix half a pint of yeast, by about 2 gallons at a time, and stir it well; let it ferment for 24 hours, with a sack over it; then put it into a barrel; keep it well filled up; bung it down in three days, and in three months you will have 36 gallons of good ale. Beware of using the water *too hot*, as it will prevent the draining off of the liquor, by *setting* the grain. Dried raw grain will drain better by mixing with it about a handful of oat-chaff before the first water.

BRICKLAYING. In walling, in dry weather, when the work is required to be firm, the best mortar must be used; and the bricks must be wetted, or dipped in water. No part of a wall should be carried higher than one scaffold, without having its contingent parts added to it.

In the *English bond*, a row of bricks is laid lengthwise on the length of the wall, and is crossed by another row, which has its length in the breadth of the wall, and so on alternately. Those courses in which the lengths of the bricks are disposed through the length of the wall, are termed *stretching courses*, and the bricks *stretchers*: and those courses in which the bricks run in the thickness of the lengths of the walls, *heading courses*, and the bricks *headers*.

*Flemish bond*, consists in placing a header and a stretcher alternately in the same course. The latter is deemed the neatest, and most elegant; but, in the execution, is attended with great inconvenience, and in most cases does not unite the parts of a wall with the same degree of firmness as the English bond. In general, it may be observed, that, whatever advantages are gained by the English bond in tying a wall together in its thickness, they are lost in the longitudinal bond; and *vice-versa*. To remove this inconvenience, in thick walls, some builders place the bricks in the cone at an angle of 45 degrees, parallel to each other throughout the length of every course, but reversed in the alternate courses; so that the bricks cross each other at right angles.

In the winter, it is very essential to keep the unfinished wall from the alternate effects of rain and frost; for if it is exposed, the rain will penetrate into the bricks and mortar, and, by being converted into ice, expand, and burst or crumble the materials in which it is contained. The decay of buildings, so commonly attributed to the effects of time, is, in fact, attributable to this source.

A number of very pleasing cornices and other ornaments may be formed in brick-work, by the mere disposition of the bricks, without cutting; and if cut, a simple champher will be sufficient, and if due care were taken to rub them exact to the gauge, their geometrical bearings being united, they would all tend to one centre, and produce a well-proportioned and pleasing effect. In steining wells, it is necessary first to make a centre, consisting of a boarding of inch or inch-and-a-half stuff, ledged within three circular rings, upon which the bricks, all headers, are laid. The vacuity between the bricks towards the boarding, are to be filled in with other pieces of brick. In steining wells and building cesspools, a rod of brick-work requires at least 4,760 bricks.

Brick-work is measured and valued by the rod. The contents of a rod of brick-work is $16\frac{1}{2}$ feet square; consequently, the superficial rod contains 272·25, or $272\frac{1}{4}$ square feet; but 272 superficial feet is the standard.

The standard thickness of a brick wall is $1\frac{1}{2}$ brick laid lengthwise; therefore, if 272 square feet be multiplied by 13 inches, the result will be 306 cubic feet, or a rod.

A rod of standard brick-work, making the necessary allowance for mortar and waste, will require 4,500 bricks; but this quantity is of course ruled by the size of the brick, and the closeness of the joints.

A foot of reduced brick-work requires 17 bricks; a foot superficial of marl facing, laid in Flemish bond, 8 bricks; and a foot superficial of gauged arches, 10 bricks. In paving, a yard will require 82 paving bricks, or 48 stock bricks, or 38 bricks laid flat.

A square of tiling contains 100 superficial feet; and requires, of plain tiles, 800 at a six-inch gauge, 700 at a seven-inch gauge, or 600 at an eight-inch gauge.

The distances between the respective

laths must depend on the pitch of the roof; and one roof may require a 6, 7, and 8-inch gauge. For instance, a kirt roof will require, in the kirt part, a 7½ or 8-inch gauge, and in the upper part 6, 6½, or 7-inch, the gauge decreasing in the ratio of the angle of elevation.

A square of plain tiling will require a bundle of laths, more or less, according to the pitch; with two bushels of lime, one bushel of sand, and a peck of tile-pins.

Laths are sold by the thousand, or bundle; and each bundle is supposed to contain 100 laths, though the exact number depends on the length; the 3 feet containing 5 score, the 4 feet 4 score, the 5 ft. 3 score, and so on in proportion.

A square of pan-tiling requires 180 tiles, laid at a 10-inch gauge; and one bundle, containing 12 laths, 10 feet long.

In lime measure, 25 struck bushels, or 100 pecks, make a hundred of lime; 8 gallons, a bushel dry measure; and 268 cubic inches, one gallon.

In measuring sand, 24 heaped, or 30 struck bushels, make one load; and 24 cubic feet weigh one ton.

A load of mortar, which ought to contain half a hundred of lime, with a proportionate quantity of sand, is 27 cubic feet, or a yard each way.

In measuring the footing of a wall, multiply the length and the heighth of the courses together; then multiply the product by the number of half-bricks in the mean breadth, divide the last product by 3, and the quotient is the answer in reduced feet. Instead of measuring the height of the footing, it is customary to allow three inches to each course in height, or multiply the number of courses by 3, which gives the heighth in inches.

In taking dimensions for work, it is usual to allow the length of each wall on the external side, to compensate for plumbing the angles; but this practice must not be resorted to for labour and materials, as it gives too much quantity in the height of the building or story by two pillars of brick; and in the horizontal dimensions by the thickness of the walls.

In measuring walls, faced with bricks of a superior quality, most surveyors measure the whole as common work, and allow an additional price per rod for the facing, as the superior excellence of the work and quality of the bricks may deserve.

Every recess or aperture made in any of the faces must be deducted; but an allowance per foot lineal should be made upon every right angle, whether external or internal, excepting when two external angles may be formed by a brick in breadth, and then only one of them must be allowed.

If the breast of a chimney project from the face of the wall, and is parallel to it, the best method is, to take the horizontal and vertical dimensions of the face, multiply them together, and multiply the product by the thickness, taken in the thinnest part, without noticing the breast of the chimney; then find the solidity of the breast itself, add these solidities together, and the sum will give the solidity of the wall, including the vacuities, which must be deducted for the real solidity.

A row of plain tiles, laid edge to edge, with their broad surfaces parallel to the termination of a wall, so as to project over the wall at right angles to the vertical surface, is called *single plain tile creasing*; and two rows, laid one above the other, the one row breaking the joints of the other, are called *double plain tile creasing*.

Over the plain tile creasing a row of bricks is placed on edge, with their length in the thickness of the wall, and are called a *barge course*, or *cope*.

The bricks in gables, which terminate with plain tile creasing coped with bricks, in order to form the sloping bed for the plain tile creasing, must be cut, and the sloping of the bricks thus, is called *cut splay*.

Plain tile creasing and cut splay are charged by the foot run; and the latter is sometimes charged by the superficial foot.

A brick wall built in pannels between timber quarters is called *brick nogging*; and is generally measured by the yard square, the quarters and nogging pieces being included in the measure.

*Pointing* is the filling up the joints of the bricks after the walls are built. It consists in raking out some of the mortar from the joints, and filling them again with blue mortar, and in one kind of pointing, the courses are simply marked with the end of a trowel, called *flat-joint pointing*; but if, in addition to flat-joint pointing, plaster be inserted in the joint with a regular projection, and neatly paved to a parallel breadth, it is termed *hick pointing*, or *hick-joint pointing*, or formerly, *hick, and patt*. Pointing is measured by the foot superficial, including, in the price, mortar, labour, and scaffolding.

Rubbed and gauged work is set in putty or mortar; and is measured either by the foot superficial, or the foot run, according to the manner in which it is constructed.

In measuring canted bow-windows, the sides are considered as continued straight lines; but the angles on the exterior side of the building, whether they be external or internal, are allowed for in addition, and paid for under the denomination of *run of bird's mouth*.

All angles within the building, if oblique, from whatever cause they are made, either by straight or circular bows, or the splays of windows, are allowed for, under the head of *run of cut splay.*

Brick cornices are measured by the lineal foot; but as various kinds of cornices require more or less difficulty in the execution, the price must depend on the labour and the value of the material used.

Garden walls are measured the same as other walls, but if interrupted by piers, the thin part may be measured as in common walling, and the piers by themselves, making an allowance, at per foot run, for the right angles. The coping is measured by itself, according to the kind employed.

Paving is laid either with bricks, or tiles, and is measured by the yard square. The price, per yard, is regulated by the manner in which the bricks or tiles are laid, whether flat or edge-ways, or whether any of them be laid in sand or mortar.

The circular parts of drains may be reduced either to the standard, or the cubic foot; and the number of rods may, if required, be taken. The mean dimensions of the arch may be found, by taking the half sum of the exterior and interior circumferences; but, perhaps, it were better to make the price of the common measure, whether it be a foot, yard, or rod, greater as the diameter is less.

Quantity of bricks necessary to construct a piece of brick-work of any given dimensions, from half a brick to two bricks and a half in thickness; and by which the number for any thickness may be found, at the rate of 4,500 bricks to the rod of reduced brick-work, including waste.

| Area in feet of wall. | One Brick. | One and a half Brick. | Two and a half Bricks. |
|---|---|---|---|
| 1 | 11 | 16 | 27 |
| 2 | 22 | 33 | 55 |
| 3 | 33 | 49 | 82 |
| 4 | 44 | 66 | 110 |
| 5 | 55 | 82 | 137 |
| 6 | 66 | 99 | 165 |
| 7 | 77 | 115 | 193 |
| 8 | 88 | 132 | 220 |
| 9 | 99 | 148 | 288 |
| 10 | 110 | 165 | 275 |
| 100 | 1102 | 1654 | 2757 |
| 1000 | 11,029 | 16,544 | 27,573 |

Number of rods contained in any number of superficial feet, and from half a brick to two and a half bricks; and thence, by addition, to any number, and to any thickness, at the rate of 4,500 bricks to the rod.

| Feet sup. | One brick. | One and a half brick. | Two and a half bricks. |
|---|---|---|---|
| | R. Q. F. In. | R. Q. F. In. | R. Q. F. In. |
| 1 | 0 0 0 8 | 0 0 1 0 | 0 0 1 8 |
| 2 | 0 0 1 4 | 0 0 2 0 | 0 0 3 4 |
| 3 | 0 0 2 0 | 0 0 3 0 | 0 0 5 0 |
| 4 | 0 0 2 8 | 0 0 4 0 | 0 0 6 8 |
| 5 | 0 0 3 4 | 0 0 5 0 | 0 0 8 4 |
| 6 | 0 0 4 0 | 0 0 6 0 | 0 0 10 0 |
| 7 | 0 0 4 8 | 0 0 7 0 | 0 0 11 8 |
| 8 | 0 0 5 4 | 0 0 8 0 | 0 0 13 4 |
| 9 | 0 0 6 0 | 0 0 9 0 | 0 0 15 0 |
| 10 | 0 0 6 8 | 0 0 10 0 | 0 0 16 8 |
| 11 | 0 0 7 4 | 0 0 11 0 | 0 0 18 4 |
| 12 | 0 0 8 0 | 0 0 12 0 | 0 0 20 0 |
| 13 | 0 0 8 8 | 0 0 13 0 | 0 0 21 8 |
| 14 | 0 0 9 4 | 0 0 14 0 | 0 0 23 4 |
| 15 | 0 0 10 0 | 0 0 15 0 | 0 0 25 0 |
| 16 | 0 0 10 8 | 0 0 16 0 | 0 0 26 8 |
| 17 | 0 0 11 4 | 0 0 17 0 | 0 0 28 4 |
| 18 | 0 0 12 0 | 0 0 18 0 | 0 0 30 0 |
| 19 | 0 0 12 8 | 0 0 19 0 | 0 0 31 8 |
| 20 | 0 0 13 4 | 0 0 20 0 | 0 0 33 4 |
| 21 | 0 0 14 0 | 0 0 21 0 | 0 0 35 0 |
| 22 | 0 0 14 8 | 0 0 22 0 | 0 0 36 8 |
| 23 | 0 0 15 4 | 0 0 23 0 | 0 0 38 4 |
| 24 | 0 0 16 0 | 0 0 24 0 | 0 0 40 0 |
| 25 | 0 0 16 8 | 0 0 25 0 | 0 0 41 8 |
| 26 | 0 0 17 4 | 0 0 26 0 | 0 0 43 4 |
| 27 | 0 0 18 0 | 0 0 27 0 | 0 0 45 0 |
| 28 | 0 0 18 8 | 0 0 28 0 | 0 0 46 8 |
| 29 | 0 0 19 4 | 0 0 29 0 | 0 0 48 4 |
| 30 | 0 0 20 0 | 0 0 30 0 | 0 0 50 0 |
| 100 | 0 0 66 8 | 0 1 32 0 | 0 2 30 8 |
| 500 | 1 0 61 4 | 1 3 24 0 | 3 0 17 4 |
| 1000 | 2 1 54 8 | 3 2 48 0 | 6 0 34 8 |

BRICKS, are a composition of clay, sand, and ashes with water, cast in moulds dried and burnt for two or three days in open kilns. The roman bricks were 17 long, 11 broad, and $2\frac{1}{2}$ or 3 thick. The modern slatuta brick is 9 long, $4\frac{1}{2}$ broad, and 3 thick, so as to fit in layers.

Lawful bricks may be $8\frac{1}{2}$ inches long, $2\frac{1}{2}$ thick, and 4 wide. Tiles $13\frac{1}{2}$ long, $\frac{1}{2}$ thick, and $9\frac{1}{2}$ wide. About 1,100 millions of bricks, and 75 millions of tiles, are made annually, 40 times as many in England and Wales as in Scotland.

The earth proper for bricks is a clayey loam, neither abounding too much in argillaceous matter, which causes it to shrink in the drying; nor in sand, which renders it heavy and brittle. As the earth before it is wrought, is generally brittle and full of extraneous matter, it should be dug some time, that it may be sufficiently mellowed, and thus facilitate the operation of tempering. For good bricks it should always have one winter's frost, but the longer it lies exposed, and the more it is turned over and wrought with the spade, the better.—Tempering is performed by the treading of men or oxen, and in some places by means of a clay mill worked by a horse.

The moulding of bricks is a very simple operation, and the day's labour of a handy workman, employed from 5 in the morning till 8 at night, is about 5,000. The clay is brought to the moulder's bench in lumps. The moulder, having dipped his mould into dry sand, works the clay into it, and with a flat smooth stick strikes off the superfluous earth. The bricks are then carried to the hack, ranged diagonally, to give passage to the air. In six or eight days more they are ready for the fire.

The kiln is usually 13 ft. long by $10\frac{1}{2}$ ft. wide, and about 12 ft. high, and holds 20,000 bricks. The walls are 14 inches thick, inclining towards each other at the top. The bricks are placed on flat arches, having holes between them resembling lattice-work; the kiln is then covered with pieces of tiles and bricks, and some wood put in to dry them with a gentle fire. This continues two or three days, and the mouths of the kiln are then closed, with pieces of brick and wet brick earth, leaving room to receive faggots of furze, fern, or heath. The kiln is supplied with these until its arches look white and the fire appears at top, upon which the fire is slackened and the kiln allowed to cool. This heating and cooling is repeated for two days.

Mr. Mencke, of Peckham, has patented improvements in preparing materials for, and in making bricks. His improved method of preparing the materials consists in adding to the clay or brick-earth, after it has been mixed with chalk, a quantity of sulphuric acid, for the purpose of causing the materials to unite, and to dry more quickly. His method of manufacturing the bricks consists in placing the brick earth, when properly prepared, and mixed with chalk, sulphuric acid, and the other materials usually employed, on a frame subdivided into compartments the size of the intended bricks, which is placed on the lower stage of a compound press, consisting of a frame and stages similar to the usual packing presses; the upper stage is attached to a powerful screen, with a fly-wheel, and the lower stage to the piston-rod of an hydraulic press. The lower stage being thus loaded, is raised by hydraulic pressure to an appropriate elevation, when blocks to fit into the divisions of the brick-frame attached to the upper stage of the press are brought down upon the brick earth by the power of the fly and screw. The pressure is then removed from the bricks, by permitting a portion of the water to escape from the press, and the bricks are carried to an arch-roofed building, furnished with a fire-place and flue, and properly ventilated, to accelerate their drying. The process is completed by burning them in a building precisely similar to that in which they are dried.

Floating Bricks. A mineral agaric, or fossil meal, so porous a stone, that, in Tuscany, bricks are made of it which swim in water.

*Tiles* differ from bricks only in shape. They are burnt in kilns, which resemble potters' ovens. The kilns are divided into stories by brick floors, upon which the tiles are piled, in the same manner as in stone-ware kilns.

Common articles of pottery, as chimney-pots, garden-pots, pans, pipkins, and such like articles, are burned in similar kilns, and some of these wares are glazed, by a slip of litharge, either alone or mixed with black manganese.

Fire Bricks are also made, which bear an intense heat without melting. Of this kind are Windsor bricks, made of a red clay from Hedgerley, near Windsor; these bricks are cut or ground nearly as easy as chalk; Stourbridge bricks are, on the contrary, extremely hard, like stoneware, but of an uniform texture and dark colour: Welsh fire-clumps resemble ordinary bricks, and are of a very coarse texture.

BRIDGES. The most ancient stone bridge in England is the Gothic triangular bridge at Croyland in Lincolnshire, said to have been built in 860. The ascent is so steep that none but foot-passengers can go over it. The longest stone bridge in England is that over the Trent at Burton, in Staffordshire, built in the 12th century, of squared free-stone. It consists of 34 arches, and is 1545 ft. long. The first bridge of cast-iron ever erected was that over the Severn, about 2 miles below Colebrookdale, in 1777. It is an arch composed of five ribs, forming the segment of a circle. Its chord is 100 ft. long, and its height 45 feet. The second cast-iron bridge was designed by Thomas Paine, and the materials were used in constructing the bridge at Bishops Wearmouth. The chord of the arch is 240 ft. long, the height 30 ft. The Southwark bridge over the Thames is, at present, the noblest iron bridge in the world. It consists of three arches, and the chord of the middle arch is 240 ft. long, and its height 24ft. Germany is the school for wooden bridges; that over the Rhine, at Schaffhausen, was 364 ft. in length, and 18 ft. broad. Several other fine arched wooden bridges have been erected, in Germany, by Wiebeking. The Trenton bridge over the Delaware is the segment of a circle 345 ft. in diameter. Its chord measures 200 ft. its height, or versed sine, is 32 ft. and the height of the timber-framing of the arch, at its vertex, is no more than 2 ft. 8 inches. The timber bridge over the Schuylkill, at Philadelphia, is 340 ft. The versed sine is only 20 ft. and the height of the wooden framing, at the vertex, 7 ft.

*Suspension Bridges* are derived from the rope bridges of South America and the East. The most remarkable one is that constructed by Telford over the Menai strait, in North Wales. The roadway is 100 ft. above the surface of the water at high tide, and the opening between the points of suspension 560 ft. The platform is 30 ft. in breadth. The whole is suspended from 4 lines of strong iron cables by perpendicular iron rods, 5 ft. apart. The cables pass over rollers on the tops of pillars, and are fixed to iron frames under-ground, and kept down by masonry. The weight between the points of suspension is 489 tons.

Capt. Brown has carried the suspension principle to its extent, both in bridges and piers, as at Brighton, Kelso, Aberdeen, &c.

An arch will fail if the materials are too soft, if the abutments are insecure, if any part of the work is defective, or if the materials afford too little resistance. In these cases the curvature is increased on each side the key-stone, the pressure on it diminished, and the whole falls.

All bridges should be on piles or rocks. The piles should be from 7 to 16 ft., and shod with iron, and driven till 30 or 40 strokes of the pile-engine moves them but an inch.

An iron bridge is stronger than another, owing to the great power necessary to crush it. The abutments should be solid masonry. The elliptical arch best supports an unequal pressure. A bridge is like a single mass standing on its abutments. If it weighed 10,000 tons it would require 7,000 tons on the crown of the arch to overset it, as an abstract principle. The horizontal thrust is equal to 15–16ths of the weight of a bridge. Reynolds determined that it requires 400 tons to crush a cube of a quarter of an inch of gun metal, but it is thought to be overrated. Before centres are removed, the parts of a bridge should be well wedged into one compact mass, whether of stone, wood, or iron.

The Strand bridge, London, has 9 elliptical arches, 120 ft. span and 35 ft. rise, with piers of 20 ft. The road and foot ways are 42 ft. A cubic yard of the granite weighs 2 tons, of the brick work 1 ton, and of the earth 1 ton $2\frac{1}{2}$ cwts. An arch contains 50,622 cubic feet, and weighs equal to 68,000 ft. of granite, 2,500 yards or 5,000 tons, and the whole 45,000 tons.

Bigelow thus describes the following principal varieties:—1. *Wooden bridges*, when built over shallow and sluggish streams, are usually supported upon piles driven into the mud at short distances, or upon frames of timber. But, in deep and powerful currents, it is necessary to support them on strong stone piers and abutments, built at as great a distance as practicable from each other. The bridge, between these piers, consists of a stiff frame of carpentry, so constructed, with reference to its material, that it may act as one piece, and may not bend, or break, with its own weight and any additional load to which it may be exposed. When this frame is straight, the upper part is compressed by the weight of the whole, while the lower part is extended, like the tie-beam of a roof. But the strongest wooden bridges are made with curved ribs, which rise above the abutments in the manner of an arch, and are not subjected to a longitudinal strain by extension. These ribs are commonly connected and strengthened with diagonal braces, keys, bolts, and straps of iron. The flooring of the bridge may be either laid above them or suspended by trussing underneath them. 2. *Stone bridges* consist of regular arches, built upon stone piers constructed in the water, or upon abutments at the banks. Above the arches is made a level or sloping road. From the nature of the material, these are the most durable kind of bridges, and many are now standing, which were built by the ancient Romans. The stone piers, on which bridges are supported, require to be of great solidity, especially when exposed to rapid currents, or floating ice. Piers are usually built with their greatest length in the direction of the stream, and with the extremities pointed or curved, so as to divide the water, and allow it to glide easily past them. In building piers, it is often necessary to exclude the water by means of a *coffer-dam*. This is a temporary enclosure, formed by a double wall of piles and planks, having their interval filled with clay. The interior space is made dry by pumping, and kept so till the structure is finished.—3. *Cast-iron bridges* have been constructed out of blocks or frames of cast-iron, so shaped as to fit into each other, and, collectively, to form ribs and arches. These bridges possess great strength, but are liable to be disturbed by the expansion and contraction of the metal with heat and cold.—4. In *Suspension bridges*, the flooring or main body of the bridge is supported on strong iron chains or rods, hanging, in the form of an inverted arch, from one point of support to another. The points of support are the tops of strong pillars or small towers, erected for the purpose. Over these pillars the chain passes, and is attached, at each extremity of the bridge, to rocks or massive frames of iron, firmly secured under-ground. The great advantage of suspension bridges consists in their stability of equilibrium, in consequence of which a smaller amount of materials is necessary for their construction than for that of any other bridge. If a suspension bridge be shaken, or thrown out of equilibrium, it returns by its weight to its proper place, whereas the reverse happens in bridges which are built above the level of their supporters.—5. *Floating bridges.* Upon deep and sluggish water, stationary rafts of timber are sometimes employed, extending from one shore to another, and covered with planks, so as to form a passable bridge. In military operations, temporary bridges are often formed by planks laid upon boats, pontoons, and other buoyant supporters.

*Number and Weight of Articles of Iron Work furnished for the Hammersmith Suspension Bridge.*

2646 links, 8 ft. 9¾ inc. to the centre of the holes drilled to receive the joint bolts—5 inc. wide, 1 inc. thick: each end of these links for 10 inc. 8 inc. wide, 213 tons 16 cwt. 14 lbs.

36 circular links, 5 ft. 9 inc. to centre of the holes, to rest on the rollers of the carriages in the towers; upper line of chains, 5 inc. wide, 1⅞ inc. thick; the 8 inc. wide for 10 inc. each end;

72 links, 3 ft. 10 inc. wide, to join do.;

72 do. 7 ft. wide, to join do.;

18 do. 9 ft. 10 inc. centre of chains, upper line, do.;

18 do. 4 ft. 6 inc. next retaining link, Surrey side;

18 do. 10 ft. 8¼ inc. next retaining link, Middlesex side;

36 circular links, 5 ft. 4 inc. wide, to rest on the rollers of the carriages in the towers;

72 links, 7 ft. 4 inc. to join lower line of chains;

36 links, 9 ft. 3 inc. centre of chains, lower line;

18 links, 9 ft. 4 inc. to join retaining links, Surrey side; 18 do. 6 ft. 9 inc. to join retaining links, Middlesex side, 26 tons 1 cwt. 22 lbs.

72 retaining links, 4 ft. 7 inc.; one end of each of these links 2 inc. thick, for 18 inc. with oval holes, 4½ inches by 9, to receive the retaining bars, 5 tons 16 cwt. 3 qrs. 26 lbs.

16 retaining bars, 4½ inc. by 9. 2 ft. 6 inc. and 3 ft. 6 inc. long, fitted to the retaining links, 2 tons 8 cwt. 2 qrs. 22 lbs.

3762 side plates, 1 ft. 3 inc. to the centre of the holes, 8 inc. wide, 1 inc. thick, drilled as the long links, 1 inc. hole in the centre, to receive bolt for vertical links; 22 do. 2 ft. 1½ inc., do. do., 83 tons, 8 cwt., 2 qrs., 11 lbs.

688 joint bolts, 19 inc. long, turned to 2¾ inc. and screwed at each end, 3 inc. 3-16ths square thread, for the 6-bar chain; 688 do. 13 inches long, turned as above, for 3-bar chain, 15 tons, 1 cwt., 5 lbs.

2752 cast-iron nuts for do., 30 tons, 6 cwt., 2 qrs., 17 lbs.

1288 vertical links, 12 inc. long, 1 inc. square iron, 1 inc. hole at each end, to receive a bolt to connect the suspension rods, 3 tons 2 qrs.

96 suspension rods, from 1 ft. 8 inc. to 31 ft. ½ inc. between the towers and retaining piers, on the Middlesex side; 324 do. from 2 ft. 4½ inc. to 31 ft. 7 inc. between the towers; 96 do. from 1 ft. 8 inc. to 31 ft. ½ inch between the towers and retaining piers, on the Surrey side, 14 tons, 5 cwt., 12 lbs.

(These rods are 1 inc. square, with a socket at the upper end, to receive the bolts, to connect them to the vertical links, and the lower end 2 inc. by 1½ inc. with a mortice 5 inc. by ¾, for the gibbs and keys, to support the beams of the road way.)

1370 bolts, screwed, from 3 inc. to 13, for the vertical links and suspension rods, 2 tons, 1 cwt., 2 qrs., 22 lbs.

1280 double keys, and 630 gibbs, for the lower end of suspension rods, 1 ton, 9 cwt., 3 qrs., 20 lbs.

657 toras beads, to fill in between the sockets of suspension rods and vertical links, 4 cwt., 2 qrs., 24 lbs.

8 cast-iron double standards on plates, for towers, 26 tons, 14 cwt., 16 lbs.

36 cast-iron rollers, 14½ inc. long, 11 inc. diameter, with wrought-iron spindles 3 inc. diameter, resting on brass bearings, for the standards and the 6-bar chain to pass over; 36 do. 8½ inc. long, 11 inc. diameter, for 3-bar chain to pass over, 9 tons, 18 cwt., 1 qr., 26 lbs.

144 brass bearings for do., 13 cwt., 4 lbs.

Screwed bolts and nutts for the standards, 6 cwt., 1 qr., 13 lbs.

8 cast-iron retaining plates, (cast in London,) 30 tons.

16 saddles for do. to receive the retaining bars for the end or retaining link; 24 packing pieces for do. 6 tons, 9 cwt., 22 lbs.

Total, 472 tons, 2 cwt., 2 qrs., 24 lbs.

United wires have double the strength of single bars of iron of equal dimensions, and being more manageable have in many cases been preferred in the construction of bridges.

BRIDLE, the head-stall, bit, and reins by which a horse is governed. The origin of it is of high antiquity. The parts are the snaffle or bit; the head-stall, or leathers from the top of the head to the rings of the bit; the fillet, over the forehead, and under the fore-top; the throat-band, which buttons under the throat; the reins; the nose-band, buckled under the cheeks; the trench, the cavesan, the martingal, and the chaff-halter.

BRIMSTONE OINTMENT. In 4 oz. of simple ointment mix 10 grs. of essence of lemon, and 1 oz. of flowers of sulphur.—*See* SULPHUR.

BRISTLES, for brush-makers, &c. are those of the hog and wild boar. The Baltic supplies us with nearly 2 millions of lbs. annually.

BRITISH GUM, used by calico printers, is made by heating starch to 600° or 700°, when it swells and turns brown.

BRITTLENESS, arises when the atoms of bodies are in a state of disturbance by heat, and are suddenly cooled so as thereby to be retained in relative positions which do not accord with the regular metallic structure. The coherence is thus affected, and the metal easily breaks or is brittle. The remedy is very gradual cooling, so that the atoms may re-adjust themselves.

Glass and steel present phenomena of this kind, and also cast-iron suddenly cooled when tapped and let out in the sand. The qualities of brittleness and toughness in metals may often arise from some inadvertency in cooling during their separation in the large way.

BRODUM'S NERVOUS CORDIAL, is compounded of tinctures of gentian, calumba, cardamom, and bark, with spirit of lavender and wine of iron.—*Paris.*

BROKER; an agent who is employed to conclude bargains, or transact other business, for his employer, for a certain fee or premium. Brokers are of several kinds; merchandise, money, exchange, ship, insurance, real estate, pawn, stock-brokers, &c. Exchange brokers negotiate notes and bills of exchange; money-brokers exchange different kinds of money; these two classes are not unfrequently united. Merchandise-brokers make contracts for the sale of merchandise. Pawn-brokers make it their business to lend money upon pawns. Insurance-brokers are those whose business it is to procure insurance of vessels at sea, or bound on a voyage.

BROMINE (75,) has been obtained in very small quantities from sea-water and the ashes of sea-weeds. It is a fluid of a hyacinth-red colour, when viewed by light transmitted through thin strata. At a temperature a few degrees below 0° it suddenly congeals, and is very brittle. Its odour is extremely disagreeable and intense; its taste unpleasant and very powerful. It corrodes the skin and colours it yellow, but not permanently; it is very poisonous; its specific gravity is nearly 3; it is very volatile; gives off red vapours at common temperatures, and boils at 116°·5. It destroys the colour of litmus, and even of indigo.

*Bromine* and *Chlorine*, or *Chloride of Bromine*, has strong bleaching powers.

BRONCHOCELE, or the Derbyshire neck, is a distorted enlargement of the forepart of the neck, chiefly in females. It affects the whole gland, or the 2-side, or the middle lobe, and may continue through life without affecting the general health, but it often increases to a frightful size. As lime-water is believed to be a cause, so distilled water, so easily procured, is a preventive, as well as change of residence. The tumour contains cells, filled with a viscid fluid. Burnt sponge, mercury, and iodine, as containing the principle of burnt sponge, have been prescribed as specifics. The tincture of iodine, each grain of which contains 20 minims of iodine, is to be taken, in doses not exceeding of half a fluid drm. twice a day; and it is made by dissolving 2 drs. of iodine in 3 ozs. of proof spirit. It should be taken when the stomach is empty, and the constitution free from other disorders, since its operation is violent. In South America, and in Switzerland, it destroys the understanding of its victims, but in the midland counties of England, it is merely an increasing deformity.—*Crawford. Ency. Pr. Med.*

BRONZES, in archæology; works of art cast in bronze. The ancients used bronze for a great variety of purposes: arms and other instruments, medals and statues, of this metal, are to be found in all cabinets of antiquities. Egyptian idols of bronze are contained in the British museum. The moderns have also made much use of bronze, particularly for statues exposed to accidents, or the influence of the atmosphere, and for casts of celebrated antiques. The moulds are made on the pattern, of plaster and brick-dust. The parts are then covered on the inside with a coating of clay as thick as the bronze is intended to be. The mould is now closed, and filled on its inside with a nucleus or core of plaster and brick-dust, mixed with water. When this is done, the mould is opened, and the clay carefully removed. The mould, with its core, are then thoroughly dried, and the core secured in its position by bars of bronze, which pass into it through the external part of the mould. The whole is then bound with iron hoops, and the melted bronze is poured in through an aperture left for the purpose: of course, the bronze fills the same cavity which was previously occupied by the clay, and forms a metallic covering to the core.

It is afterwards made smooth by mechanical means.

Bronze of a good quality acquires, by oxydation, a fine green tint. This appearance is imitated by an artificial process, called *bronzing*. A solution of sal ammoniac and salt of sorrel in vinegar, is used for bronzing metals. Any number of layers may be applied, and the shade becomes deeper in proportion to the number applied. For bronzing sculptures of wood, plaster, figures, &c., a composition of yellow ochre, Prussian blue, and lamp-black, dissolved in glue-water, is employed.

Although copper medals can be struck from cold blanks by bronze dies, yet, in striking hot bronze blanks, the process does not succeed well, although better than when steel dies are used, as the heated bronze softens the steel, so that the fine edges of the impression are speedily effaced, and the surface of the die calcines and comes off in scales. The proper degree of heat to be given to the bronze is very difficult to ascertain; at a brown-red heat the impression is but faint, at a yellowish red the blank cracks on the edges. It is, however, found that bronze dies and punches are superior to steel, when the object to be struck is necessarily heated, or when the die or punch itself is required to be hot. It is found that bronze, or brass, for a mixed metal of 107 parts of zinc, with 892 of copper, ought to be melted as quickly as possible, so that 10 lbs. of metal should not take more than 12 or 15 minutes, and that the moulds should be so thin that the cast bronze may cool very quickly. The medals being cast, are finished by dies with a screw-press; as the relief is nearly complete, a very few strokes of the press is sufficient to finish them, and they do not require the heats that are required to be given to medals when struck from blanks, as in this case $1\frac{1}{2}$-inch medals, even of pure copper, require 5 or 6 heatings, and 10 or 12 strokes; $1\frac{7}{8}$-inch medals, 7 or 8 heatings, and 14 or 16 strokes; 2-inch medals, 12 or 16 heatings, and 24 or 32 strokes; and $2\frac{1}{2}$-inch, or larger medals, 30 or 40 heatings, and from 90 to 120 strokes of the press.

*Bronze Powder* is made by making verdigris 8 oz., tutty 4 oz., borax, nitre, ana 2 oz., corrosive sublimate 2 drs. into a paste with oil, and melting them together. It is used in japan work, as a gold colour.

*To Bronze Plaster Figures.*—For the colour of the ground take Prussian blue, verditer, and spruce ochre, grind them separately in oil, and mix them in such proportions as will produce the desired colour. Then grind Dutch metal in a part of this composition, laying it with judgment on the prominent parts of the figure.

In bronzing iron, the Dutch metal is usually ground by itself to a very fine powder, and rubbed on the ground by the finger in a dry state.

*Bronzing Tin.*—To obtain complete success in bronzing medals of tin, the two following solutions must be employed:—The first, a wash, is composed of one part of iron, one part of sulphate of copper, and twenty parts, by weight, of distilled water. The second solution, or bronze, is composed of four parts of verdigris and sixteen parts of white vinegar. The medals should be filed, and well cleaned with a brush, earth, and water; and, being well wiped, should have a portion of the first solution passed lightly over their faces, by means of a brush, and then be wiped; this gives a slight grey tint to the surface, and causes the ready adhesion of the verdigris, &c. The second solution is then to be rubbed over them by means of a brush, until they have acquired the deep red colour of copper; they are then to be left for an hour to dry, after which they are to be polished with a very soft brush and rouge, or the red oxide of iron, in fine powder, the breath being passed over them from time to time, to cause the adhesion of the rouge. The polish is to be completed by the brush alone, the medals being passed now and then over the palm of the hand.

BROOM, DYER'S, (*genista tinctoria.*) The flowers and leaves are aperitive and diuretic; also used to dye yellow. The *genista ovata* is used to dye yellow.

BROWNING (*for Sauces.*)—To 8 oz. of lump-sugar add a table-spoonful of water; heat till brown; add 1 oz. of salt and water to the thickness of soy.

*To make* BRUNSWICK BLACK.—Take of asphaltum 2 lbs., boiled linseed-oil ½ lb., oil of turpentine 2 pints. Melt first the asphaltum, to which add the linseed-oil, and afterwards the oil of turpentine. Useful for grates, and other common purposes; and is best applied warm or hot.

BUCHU LEAVES, from a Cape plant, are sudorific and diuretic, and useful also in rheumatism and retention of urine, taken in a small wine-glass, as an infusion, five or six times a day.

BUCKRAM, is coarse cloth, gummed and calendered.

BUCK WHEAT, (*fagopyrum,*) yields seeds which are nutritive, fattening, and well flavoured. They are made into bread and yield oil.

BUDDING.—In the Netherlands it is recommended to reverse the usual mode of raising the bark for inserting the buds, and to make the cross-cuts at the bottom of the slit, instead of the top, The bud then rarely fails of success. because it receives sufficient of the descending sap, which it cannot receive when it is under the cross-cut.

BUFF-LEATHER, is the skin of the buffalo, or elk, dressed with oil.

*To drive away* BUGS.—Make a strong decoction of red pepper, when ripe, and apply it with a common paint-brush to the joints of the bedstead, wainscotting, &c. where they usually resort, and it will speedily expel them.

*Or*, the spirit of tar, applied, by means of a small painting-brush, to the joints and crevices, or cracks, in a bedstead, and their places of retreat, is so noxious that they desert the bed where it has been used. Being volatile, it should not be used by candle-light.

BUILDING.—The essential elementary parts of a building are those which contribute to its support, enclosure, and covering. Of these, the most important are the foundation, the column, the wall, the lintel, the arch, the vault, the dome, and the roof. In laying the *foundation* of any building, it is necessary to dig to a certain depth in the earth, to secure a solid basis, below the reach of frost and common accidents. The most solid basis is rock, or gravel, which has not been moved. Next to these are clay and sand, provided no other excavations have been made in the immediate neighbourhood. From this basis a stone wall is carried up to the surface of the ground, and constitutes the foundation. Where it is intended that the superstructure shall press unequally, as at its piers, chimneys, or columns, it is sometimes of use to occupy the space between the points of pressure by an inverted arch. This distributes the pressure equally, and prevents the foundation from springing between the different points. In loose or muddy situations, it is always unsafe to build, unless we can reach the solid bottom below. In salt-marshes and flats, this is done by depositing timbers, or driving wooden piles into the earth, and raising walls upon them. The preservative quality of the salt will keep these timbers unimpaired for a great length of time, and makes the foundation equally secure with one of brick or stone.

The *wall*, another elementary part of a building, may be considered as the lateral continuation of a column, answering the purpose both of enclosure and support. A wall must diminish as it rises, for the same reasons, and in the same proportion, as the column. It must diminish still more rapidly if it extends through several stories, supporting weights at different heights. A wall, to possess the greatest strength, must also consist of pieces, the upper and lower surfaces of which are horizontal and regular, not rounded nor oblique. The walls of most of the ancient structures, which have stood to the present time, are constructed in this manner, and frequently have their stones bound together with bolts and cramps of iron. The same method is adopted in such modern structures as are intended to possess great strength and durability, and, in some cases, the stones are even dove-tailed together. But many of our modern stone walls, for the sake of cheapness, have only one face of the stones squared, the inner half of the wall being completed with brick; so that they can, in reality, be considered only as brick walls faced with stone. Such walls are said to be liable to become convex outwardly, from the difference in the shrinking of the cement.

*Rubble* walls are made of rough irregular stones, laid in mortar. The stones should be broken, if possible, so as to produce horizontal surfaces.

Modern *brick walls* are laid with great precision, and depend, for firmness. more upon their position than upon the strength of their cement. The bricks being laid in horizontal courses, and continually overlaying each other, or *breaking joints*, the whole mass is strongly interwoven and bound together. Wooden walls, composed of timbers covered with boards, are a common but more perishable kind. They require to be constantly covered with a coating of a foreign substance, as paint or plaster, to preserve them from spontaneous decomposition.

In some parts of France, and elsewhere, a kind of wall is made of earth, rendered compact by ramming it in moulds or cases. This method is called building in *pisé*, and is much more durable than the nature of the material would lead us to suppose. Walls of all kinds are greatly strengthened by angles and curves, also by projections, such as pilasters, chimneys, and buttresses. These projections serve to increase the breadth of the foundation, and are always to be made use of in large buildings, and in walls of considerable length. The *lintel*, or *beam*, extends in a right line over a vacant space, from one column or wall to another. The strength of the lintel will be greater in proportion as its transverse vertical diameter exceeds the horizontal, the strength being always as the square of the depth. The *floor* is the lateral continuation or connexion of beams by means of a covering of boards.

BULLETS and Shot.—Previous to the invention of the present *patent process*, small shot were chiefly made by cutting sheet-lead into little cubes, which were rounded by long-continued friction against one another, produced by inclosing them in an iron barrel, which was made to rotate on its axis until the cubes were reduced into spheres. Another mode, considerably analogous to the present, was also in use, that of causing lead, and also lead combined with a small portion of arsenic, to drop in a fluid state through a kind of sieve, (having perforations of a suitable size) into a vessel of water placed only a few inches beneath it.

The kind of building now used for the manufacture of shot is about 150 feet high, affording a fall of about 130 feet for the shot. The alloy consists of 40 lbs. of arsenic to a ton of lead, and is prepared and cast into pigs of about $1\frac{1}{2}$ cwt. each. By means of a suitable tackle, 10 of such pigs are drawn up through a trap-door into the melting-room at the top of the tower. Here the pigs are successively put into the cauldron, which is heated by a common furnace, having a brick-flue and chimney, terminated by an iron funnel, reaching to the top of the upper dome or lantern. When the alloy is melted, and the scoriæ properly formed, a portion of the latter is ladled by the melter into a kind of square cullender, supported in an iron frame, fixed close to the furnace; this vessel is 12 or 14 inches square, and about 3 inches deep; it has a handle like a frying-pan, and its bottom is perforated with circular holes of a size suited to the shot about to be made. The quantity of dross required being determined by the experiment of making a few shot (which are not suffered to descend below the floor of the melting-room); a man now ladles the fluid metal out of the cauldron into the perforated vessel; in running through which it is somewhat detained and cooled in passing the scoriæ, which tends to separate it in small portions, where it collects underneath the cullender at every hole in small globules, which instantly drop, and are followed by other globules in such rapid succession as to appear like rain of liquid silver. This metallic shower falls into a large tub of water, placed underneath. From the great specific gravity of the shot they do not scatter in their descent, and the workmen cross the bottom floor of the tower in perfect security.

The various sizes of the shot are distinguished by the manufacturers by the Nos. 1 to 12; the largest, No. 1, are called swan-shot; the smallest, No. 12, dust-shot; their diameter varying from 1-30th to 1-4th of an inch. The shot, when removed out of the tub, are dried by artificial heat, as they remain considerably wet, by the water being held between the little spheres. To dry them, they are scattered over a large heated iron plate, having a furnace beneath, on which they are well stirred about, and swept off as soon as dry. After this operation, they present a dead-white silvery appearance; they contain amongst them many (though but a small proportion) of imperfect shot, and the perfect differ somewhat in size; to separate these varieties from one another constitutes the next process. The dried shot are therefore taken to the sifters, who have each the management of a series of three or four sieves, placed in a row, in a reciprocating iron frame, which derives its motion from a steam-engine. The movement is effected by a horizontal revolving shaft (near the ceiling of the room,) having at the extremity a short crank, from which depends a rod, that is made to rise up and down; this vertical rod is attached, at its lower extremity, to a lever of the common bell-crank kind, which is connected to the frame containing the sieves, and therefore produces, in the latter, a reciprocating horizontal motion. Each sieve is also provided with a distinct frame, embracing its circumference, with a large joint on one side, which connects it to the general frame. A quantity of the shot being thrown into the first sieve, that portion of them which is small enough passes through its meshes, the rest that are too large are then discharged into the next sieve, by *turning over* the first on its hinge-joint, as a person would open and throw back the lid of a box. The advantage of this arrangement will be evident, when it is considered that the sieves, being constantly in rapid motion, it would be no easy matter to throw the shot from one into the other, were they separate, without spilling: whereas, by their connexion, the shot cannot be discharged otherwise than as intended. The attendant to the shifting apparatus has, therefore, only to supply the first sieve, and to discharge the contents from one to the other successively. The produce of the two first sieves is collected into separate bins, and as these contain many shot of imperfect *forms*, they are taken thence to another set of operators, who separate the bad from the good, by a process equally simple and effectual. Those which have not passed through the two first sieves of the series, are condemned as bad and are remelted.

A number of shallow quadrangular trays, the figure of which may be defined by the boundary line of a plane produced by the longitudinal section of the frustrum of a cone in the line of its axis, made of hard wood, and perfectly smooth at the bottom, are suspended from the ceiling by cords attached to the two corners of the widest ends of the trays, their other or narrowest ends resting upon the edges of a row of shot-bins. Thus arranged, a boy, who manages two of these trays, throws upon each at the widest end (that nearest to him), a small measure full of shot; he then takes hold of the trays, and giving them a gentle vibrating motion laterally, and, at the same time, raising the ends a little, to give them a slight inclination, the shot roll about, tending from side to side, those that are perfectly spherical making their way quickly off the boards into the bin at the extremity; while those that are imperfect are detained by their comparatively-sluggish movements, and being thus separated from the good, the trays are pushed forward about a foot, and their contents emptied into other pins placed beyond those containing the good shot, as before mentioned. This operation is so effectual, that it is difficult to pick an imperfect shot out of those that come to market. Four or five boys, thus employed, with two trays to each, suffice for a manufactory of the kind we have described, which makes about five tons per day; the smallest shot require the utmost care and gentlest management of the inclined plane; therefore, the eldest or steadiest hands are selected to operate upon them. The next and last part of the business, previous to the shot being bagged for the market, is to polish them; for this purpose, a cast-iron barrel, holding, perhaps, half a ton weight, is nearly filled with them, and a rotatory movement communicated to it by the engine, which causes all the little spheres to rub against each other, and give them a black lustre, materially differing from their previous argentine complexion. A curious effect is produced upon the interior of the cast-iron barrel by the friction of the shot, that of wearing it into a regular series of grooves, so that a stranger would suppose the barrel had been cast with an internal fluting.

Abortive attempts were made to manufacture bullets by pressure, so as to condense and equalize them; and the failure has not resulted from any real difficulty in accomplishing the object, but from the increase in cost. The present plan is better. The balls are first cast in moulds, consisting of two iron plates, faced so as to fit closely together, the lower plate forming one half of the bullet, and the upper plate the other half. The thickness of the upper plate is just equal to that of the half bullet, there being a hole through it above each for the purpose of casting. These plates are so placed as to form an inclined plane upon a frame made for the purpose. A hopper, to contain lead to fill the moulds, is made to slide over, and in contact with, the upper plate; and is followed by a knife, which removes all the superfluous metal; the hopper is borne down by a weighted lever, and moved by a rack and pinion. On being turned out of the moulds, the bullets are coated with black-lead, to prevent their adhering; after which, they are passed through the rolling-machine. This consists of small hoppers, into which they are first put, and by which they are delivered on to grooved rollers, properly adapted to them. Of these there are five, which they pass in succession, each with the grooves a little smaller than the preceding one.

BULK, is length, breadth, and thickness multiplied together; but when from irregularity of figure the dimensions cannot be expressed, the bulk may be determined by immersion in water, and either measuring the increase or decrease in the bulk of water, or the quantity necessary to replace it when taken out.

BUNTING, a thin woollen stuff, of which the colors and signals of a ship are usually formed.

BUOYS, are casks, or empty vessels, rising over an anchor, to which they are fixed, to indicate its position; but often made of copper, and floated in sand-banks, as warning to ships. The *can*-buoy is of a conical form, and painted with some conspicuous colour; it is used for pointing out shoals, sand-banks, &c.—The *cask*-buoy is in the form of a cask; the larger are employed for mooring, and are called *mooring*-buoys; the smaller for cables, and are known as *cable*-buoys. The buoy-rope fastens the buoy to the anchor, and should be about as long as the depth of the water where the anchor lies; it should also be strong enough to draw up the anchor, in case the cable should break. The *life* or *safety* buoy is intended to keep a person afloat till he can be taken from the water. It should be suspended from the stern of the ship, and let go as soon as any person falls overboard. A light may be attached to it, both to indicate its position to the individual in danger, and to direct the course of the boat sent to relieve him, if the accident happens by night.

BURDOCK, a common biennial plant, called *arctium*, the decoction of whose seeds and roots are diuretic and anti-scorbutic.

Burdock, *(bardana major.)* The young shoots, stripped, are eaten as asparagus. The root is used in disorders of the skin, and is diaphoretic, diuretic, and useful in dropsy. Two oz. of the fresh roots should be boiled in three pints of water to two, and the whole drank in 24 hours. The seeds are diuretic, diaphoretic, and slightly purgative.

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BURGUNDY PITCH, is made by incisions in the bark of spruce-fir. The exudations are then boiled in water, and the resin strained, under a press, through coarse cloths.

BURGUNDY WINES, are produced in the former provinces of Upper and Lower Burgundy, in a soil of a light-black or red loam, mixed with the *débris* of the calcareous rock on which it reposes. In richness of flavour and perfume, and all the more delicate qualities of the juice of the grape, they are inferior to none in the world. It is to the great skill with which the cultivation of the vine and the fermentation of the liquor are managed, that they owe those generous qualities which gave to the dukes of Burgundy the title of *princes des bon vins*, and which, as Petrarch more than hints, contributed not a little to prolong the stay of their holinesses at Avignon. They are remarkable for their spirit and powerful aroma. The finer wines of Burgundy do not bear removal, except in bottles; and, as they are not produced in great abundance, they are rarely, if ever, met with in foreign countries. It is the inferior growths which are sold under that name. The Burgundy wines are generally exported between January and May, chiefly in double casks. They keep only four or five years, and are very apt to acquire a bitter taste, which Chaptal attributes to the developement of the acerb principle. It may sometimes be partially removed by new sulphuring and refining. The most numerous are the red wines of Burgundy. The finest growths of these are the Romanée-Conty, the Chambertin, the Closbougeot, the Richebourg, the Romanée de St. Vivant, &c. They are distinguished for their beautiful colour, and exquisite flavour and aroma, combining, more than any other wines, lightness and delicacy with richness and fulness of body. Of the second class, are the *vins de primeur*, of which the Volnay and Pomard are the best; those of Beaume, distinguished above all by their pure flavour, and formerly considered the most choice of the Burgundy wines; the Macon wines, remarkable for their strength and durability; those of Tonnerre and Auxerre, &c. The white wines of Burgundy are less numerous, but not inferior in aroma and flavour. The famous Montrachet is equal to the finer red wines, and is distinguished for its agreeable nutty flavour. Of the second class are the *Goutte d'or*, so called from the splendour of its tint; La Perrière, &c.

BURNET SAXIFRAGE. Root chewed relieves the tooth-ache; the seeds are opening, and detersive, in infusion.

BURNING-GLASSES, are concentrations of the solar heat on a large surface, in a focus whose diameter is nearly the 100th of the focal distance. The heat would, therefore, be as the superfices of the glass to that of the image in the focus. In this way, it is calculated that some large glasses would produce a heat equal to 71000°, but for collateral circumstances. The effect in melting, and dispersing the most refractory substances, is astonishing. Combined plain mirrors, made to reflect their heat or light to the same spot, produce similar effects at greater distances, at 100, 200, or 400 feet. The whole is more curious and amusing than useful. With Parker's lens of 3 ft. diameter, and 6 ft. 8 inc. focus, which was 1 in. in diameter, slate and the scoria of iron were fused in 2 seconds, and gold, platina, nickel, and cast-iron, in 3 seconds.

A small lens of 6 inc. focus, and 2 or 3 inc. diameter, is useful for lighting a fire, &c. Since the heat, if 3 inches, is $3 \times 3 = 9$, at the glass, and the diameter of the focus being $\frac{6}{100}$ or ·06, and its square ·0036, then $\frac{9}{\cdot 0036}$ is 2500, for the increase of solar heat above that of the time. But supposing half to be dissipated by the figure of the surface, &c. we have 1250 times the heat of the direct rays.

BURNISHERS, consist of a dog's tooth, or piece of agate, firmly fixed in a handle, to work upon any surface which requires polishing. In finishing fine steel work, the female hand is preferred.

BURNS.—Spirits of wine, or oil of turpentine, applied the moment the accident happens, prevents the rising of blisters, which retard the cure. If the burn be considerable, the application of fresh yolk of eggs is the best substance to allay the pain, and to promote a cure. Simple cerate, composed of one part of yellow wax, and two parts of good olive-oil, or of three parts in winter, produces an effect which may be compared to that of yolk of eggs, and is less expensive.

*Burns and Scalds.*—Wheat flour is more beneficial than any other topical application to burns and scalds; it allays inflammation and pain, and effects a cure by hastening incrustation, and by uniting with the discharge. Oil of turpentine, ether, or spirits, are remedies.

BURNT SPONGE, so useful in scrophula and bronchocele, is sponge cut in pieces, and burnt in an iron vessel to powder. One to three drachms is given daily in oxymel or in honey with powdered cinnamon.

BUTTER, the product of milk, which forms important articles of food in every country. The same quantity of milk that sells for 6*d*. yields about 4*d*. if made into butter, and only 3*d*. when made into cheese. The milk of the cow yields more than twice as much cream as ewes' milk; but this is best adapted for making cheese. Cheese-making is best carried on in summer; butter in winter. The average produce of a grass-fed cow is about 5 galls. per day, from the cream of which, about 22 ozs. of butter may be made. Cows yield more milk, when milked three times a day, than when milked twice; and the milk of some cows yield more cream than that of others. The cream yielded by the last half of the milking, if the udder is properly emptied, is not less than eight, and sometimes sixteen times as much as that yielded by the first half of the milking. Water added to milk causes it to throw up a larger quantity of cream than if unmixed, but the cream is of inferior quality. Milk carried to a distance before it is set for cream, or any other way shaken, yields less cream, and is also thinner. Cream which has not acquired some degree of sourness before it is churned, requires in summer long churning, and is generally soft, tough, and gluey; and, in winter, butter will scarcely form, unless heat is applied. The stroke in churning must be regular. If the milk that drains from cream is carefully separated, the cream may be kept many weeks. The cows should be milked close to the dairy door; as soon as half the milk is drawn from each cow, it should be strained into a cream dish, which should never exceed 3 inches in depth. Wooden dishes are to be preferred, and leaden, tinned cast-iron, or earthen vessels glazed with litharge, or red lead, totally rejected. The dishes are not to be scalded, unless they have a taint. New dishes, and those that have been scalded, should have sour butter-milk kept in them before the milk. The cream is to be taken off at the end of six or twelve hours, according to the heat of the weather, and collected in a tub, having a spigot close to the bottom, that the milk that separates from the cream may be drawn off morning and evening. The cream of each milking is to be kept separate, and if in sufficient quantity also churned separately. The cream is kept in these tubs until it acquires such sourness that it will yield butter by a moderate degree of agitation; which will be three days in summer, and a week in winter. The cream being churned, and strained from the butter-milk, is to have the remains of the butter-milk carefully squeezed from it, with as little working of the butter as possible. Butter should not be touched during its making by the hand; but worked with the wooden hands used by cheesemongers.—*Anderson.*

*Cream* is composed of an oily substance, a caseous matter, and serum or whey. If it be agitated about an hour in a churn, a separation of these parts takes place, and a solid, called *butter*, and a liquid, called *butter-milk*, consisting of the whey and the caseous matter, are the products. The proportions of these products, in 100 parts of cream, are,

| | |
|---|---|
| Butter | 4·5 |
| Cheese | 3·5 |
| Whey | 92·0 |
| | 100·0 |

Chemical analysis gives stearine, elaine, and a small quantity of acid and colouring matter, as the component parts of butter. The European countries, in which oil or butter is used, may be separated by a line extending along the Pyrenees, the Cevennes, the Alps, and Mount Hæmus. To the north, the pasturage is better; cattle abound, and the food is chiefly derived from them. The olive-groves to the south supersede the use of butter by that of oil. The butter, beer, and animal food of the north of Europe, give way to oil, wine, and bread, in the warmer regions. The word *chameah*, translated *butter*, in the English version of the Bible, means some liquid preparation of milk or cream. The Hindoos make use of *ghee*, which means butter, clarified by boiling. They boil the milk two or three hours, which, when cool, is fermented with curdled milk, left to sour, churned, and, when it is sufficiently rancid, is boiled, and mixed with salt, or betel-leaf, and ruddle, to improve its taste and colour.

Cream should be kept in a deep pan, and if a churning does not take place every other day, it should be shifted daily into clean pans, and kept in a cool place. A churning should take place, at least twice a week in hot weather, and the churn remain during the whole time a foot deep in water. If the butter does not come after considerable agitation, a spoonful of vinegar may be added to each gallon. In winter, a little juice of carrots is sometimes added to the cream when put into the churn, to give it the colour of May, or Spring butter. The butter is immediately washed in many different waters, till it is perfectly cleansed from the milk.

Scalded cream butter is made by letting the milk remain in shallow earthen pans, for 12 hours in summer, and 24 hours in winter. The pans are then placed in stoves, and filled with hot embers, where they remain till bubbles rise, and the cream changes colour. It is then removed to the dairy, left for 12 hours, and skimmed from the milk, and put into the churn. Some scald the milk over the fire, and others put the cream into a wooden tub, and work it into butter by the hand.

In Lancashire, the milk of each cow is divided, the first drawn being set apart from the afterings. The first drawn being skimmed, the cream added to the whole of the afterings, which are not skimmed, but when sufficiently soured, the milk and cream are churned together.

When cows are fed on turnips, the disagreeable taste is taken off, both from the milk and butter, by adding a tea-cupful of a solution of saltpetre to every 8 gallons of milk.

Skimmed milk may be made into sour cream and wigg. It is put over-night into an open-headed tub, or small churn, with a spigot at the bottom; this is then put into a larger vessel, and hot water poured into the space between them. In the morning, the vessel of milk is taken out, and the spigot being drawn, a thin part, called wigg, runs out, and as soon as the thick part begins to run, the spigot is closed, and the thick part is poured into another vessel. When the operation succeeds properly, the thick part is nearly half the milk, and seems to be as rich as real cream, from which it can only be distinguished by its sourness.

In large dairies the labour of skimming is obviated by churning the milk entire. In warm weather, the milk is fit for churning in 48 hours, and it is usual to add a little cold water near the end of the churning, to promote the separation of the butter. In cold weather, the milk is kept a day or two longer before it is churned, and boiling water is added to it when in the churn. But milk butter is not so rich as cream-butter, though it will keep much longer sweet.

When cheese is made from unskimmed milk, butter is sometimes made from the whey, but whey butter only serves for present use in the house.

To perserve butter, it is salted, and packed in barrels, and the proportion of salt is an ounce to a pound. As this salt butter is generally cream butter, the London buttermen often wash the salt out of it, and sell it for Epping butter, as the dairies round London churn from the milk. When a private family opens a barrel of salt butter, and consumes it slowly, the butter should be covered with strong brine. Gray relates that 30 lbs. of Lancashire butter well salted, with a double allowance of salt, were put into two mugs, and each covered with $1\frac{1}{4}$ pint of brine. After keeping in a cool cellar for 13 months, they were examined and found to be perfectly good, two years and seven weeks having elapsed; the mugs were broken by accident, and the butter being found to be perfectly good, the salt was washed out, and the butter sold for fresh butter.

Udney butter is made by using, for the pickle, a mixture of 2 lbs. of salt, 1 lb. of saltpetre, and 1 lb. of sugar beat well together. This butter is not in flavour till it has stood a fortnight after being cured.

For exportation to hot climates, butter ought to be clarified before it is salted. For this purpose it is put into a lipped vessel, and placed in a vessel of water, which is to be gradually heated till the butter is melted. It is to be kept melted for some time, to allow its mucilaginous particles to settle; the clear melted butter is then poured off from the dregs, and when sufficiently cooled is salted. Clarified butter is paler than fresh, and acquires the consistence of tallow.

Butter is sometimes preserved with honey as a delicacy. It is first clarified, and being poured off from the dregs, an ounce of honey is added to each pound of butter, and well mixed with it. It will keep for years.

Butter which adheres to the knife, when stuck into it, is factitious; and, when in the tub, the odour of the knife is a test of its quality.

The Tartars fuse butter in a water bath at 190°, and retain it in that state till the caseous matter has settled. It is then passed through a cloth, and cooled in a mixture of salt and ice. In a cool place it keeps six months. Rancid butter may be cured by similar meltings and coolings.

London consumes about 48 millions lbs. of butter per annum, or the produce of 300,000 cows. About 20,000 lbs. come from Holland and Germany.

Butter, or *Chloride, of* Arsenic, is made by distilling 6 lbs. of corrosive sublimate with 1 lb. of arsenic, in powder. The product is the chloride or butter.

Butter may be made from cream, or the milk, but in the latter case it is not churned till it has become sour and coagulated, or lappered. It is churned at 70° or 75°.

Butters (*from vegetables*) are various, as—*Boiled oil of bays, Oleum laurinum verum. O. lauri nobilis.* From bayberries, by boiling, thick like butter, green; from Italy, *7l.* to *8l.* the cwt.; retail 3s. the lb.—*Butter of laurus glauca*, used for candles.—*Myrtle-oil*, from myrtle-berries, concrete and odoriferous.—*Butter of bassia longifolia*, greenish yellow.—*Mackaw fat*, from the nuts of *cocos fusiformis.* —*Tallow of litsæa sebifera*, used for candles.——*Butter of the choorie-tree*, used as butter in India.——*Palm-oil*, yellow, sweet-scented, used for food, and in emulsions.——*Butter of cacao*, from the kernels of the chocolate-nut by boiling.——*American green wax*, from *myrica cerifera*, and other species of *myrica;* by boiling the berries in water, they yield one-fourth of their weight of wax; used to make sweet-scented candles.—*Chinese vegetable* tallow, from the seeds of *croton sebiferum*.—*Bencoolen nut-oil*, from *croton moluccanum*.—*Guy amadou*, from the fruits of the *virola sebifera*. The four last are used to make odoriferous candles.—*Pœnoe tallow*, from the fruit of *vateria indica* by boiling.—*Sassafras nut-oil*, white and butter-like.—*Cocoa nut-oil*, made by pressure, white, and used for lamps, and to make gas for lights.

BUTTER WORT, or *Yorkshire sanicle*. Its leaves heal wounds and chaps of the skin. They are also made into a purging syrup, and used to thicken milk, turn it sour, and make it keep for any time.

BUTTONS, are of all forms and materials—wood, horn, bone, ivory, steel, copper, silver, gilt, &c. The non-metallic buttons, called also *moulds*, are made by sawing them into little slips, of the thickness of the button to be made, which are then cut into the form required, by an instrument adapted to the purpose. Metallic buttons are cast in moulds, or cut by a fly-press. Any figure or inscription may be impressed on them at the same time that they are cut. The little wire ring, by which they are attached to a garment, is called *shank*, and is soldered separately on each button. The various operations of shaping the discs, forming the shanks, cutting the cloth, and covering the faces of the buttons, are all effected by Church's machine with one revolving shaft.

Button-making forms an extensive series of manufactories at and near Birmingham. The metal is flattened by rollers into a sheet, and then cut with punches on lead. It is stamped with any required ornament, and then soldered or united to another place, in which an eye or shank is fixed. The manipulations are various for different kinds of buttons.

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CABBAGE, including many species of the numerous genus of *brassica*, is a biennial plant. There are several species of the wild or original stock, from which the garden cabbage has been derived by cultivation. These are natives of various parts of Europe, Africa, &c. and, although very remote in appearance, from the full round head which our plants present, are scarcely more so than are the kale, cauliflower, brocoli, &c. all of which belong to the cabbage family. In general terms, we may consider this plant as divided into three classes—the common-headed cabbage of the field and garden; the cauliflower, brocoli, &c. which form their stalks into a loose head; and the kale, colewort, &c. which grow in a natural branching way, without forming any heads at all. Of these, the common cabbage is by far the most valuable, both to man and to the beasts.

*To preserve Cabbages through the Winter*.—When they have arrived at full maturity, pull them up with the roots, reverse their crowns, and cover them up, by digging a trench on each side, and laying the earth over them till nothing but the roots are seen above ground. Before burying them, all decayed leaves must be removed.

*Cabbage-seed*, or *Colza Oil*, is the beautiful economical oil which is used in France, Netherlands, &c. for domestic illumination, and, when purified, it affords a bright white light, equal to the purest coal-gas. Owing to the ignorance of our oil-pressers, this fine oil is not prepared in England; and the duty on the French and Flemish Colza oil amounts to a prohibition on its importation.

*Cabbage Tree*, is one of the tropical varieties, and a species of it has lately been successfully cultivated in the Norman Islands, by which cattle are fed in winter with much advantage.

*Cabbage-tree Bark*, is a specific for worms, taken in 1 scruple to half a drachm of powder, or 3 grains of the extract or evaporated decoction. Cold liquids should be avoided till it has operated.

CABLE, is a long thick rope, formed of three strands of hemp, and is employed for confining a vessel to its place by means of an anchor, or other fixed body. The long and heavy chains, which have been recently introduced for this purpose, are also called *cables*. Large vessels have ready for service three cables—the *sheet*-cable, the *best bower*-cable, and the *small bower*-cable. They should be at least 100 to 120 fathoms in length. A best bower-cable, 25 inches in circumference, is formed of 3240 threads. The invention of iron cables is of recent date, and they have supplanted those of hemp in ships of war. They are stronger, less liable to be destroyed by rocks, &c. It is sometimes desirable to cut the cable, when of hemp: and this contingency is provided for in iron cables by a bolt and shackle at short distances, so that, by striking out the bolt, the cable is easily separated.

In cables, 972 yards of a 1-inch rope weigh 1 cwt. ; 249 of a 2-inch ; 108 of a 3-inch ; 60 of a 4-inch ; 39 of a 5-inch ; 27 of a 6-inch ; and $7\frac{1}{2}$ of a 12-inch.

Every cable is of three strands, every strand of three ropes, every rope of three twists, and the twists have more or less threads, as the size of the cable; one-inch diameter having 48 threads, and weighing 192 lbs. For the strength or strain, in tons, divide the square of the girth by 5. Thus 2 inches diameter is $6{\cdot}283^2 = \frac{39}{5} = 8$ tons nearly. And 20 inches circumference is 80 tons, with 1943 threads, weighing 7772 lbs. Long cables have less strain than short ones.

Every merchant-vessel has three cables, viz. the main, or master cable, which is that of the chief anchor, called the sheet-cable ; and the two bowers, best and small. The ordinary length of the great cable is 120 fathoms.

In making a cable, after forming the strands, they use a machine, which they first pass between the strands, that they may turn the better and be intertwisted the more regularly together. And, to prevent any entangling, a weight is hung at the end of each strand. The cable, being properly twisted, neither too much, so as to become stiff, nor too little, so as to be weakened, is untwisted again three or four turns, that the rest may the better retain its state. The usual allowance for the diminution of length by twisting, is one-third of the whole; so that for a cable of 120 fathoms, the rope yarn must be 180 fathoms long.

The number of threads which each kind of cable is to be composed of, is always proportioned to its length and thickness; and it is by this number of threads that its weight and value are ascertained.

| *Circumf.* | *Threads.* | *Weight.* |
|---|---|---|
| 3 Inches | 48 | 192 Pounds |
| 6 | 174 | 696 |
| 9 | 393 | 1572 |
| 12 | 699 | 2796 |
| 15 | 1093 | 4372 |
| 18 | 1575 | 6296 |
| 20 | 1943 | 7772 |

CACAO, or Chocolate, a kind of cake, or hard paste, the basis of which is the pulp of the *cacao*, or chocolate-nut, a production of the West Indies and South America. The cacao-tree (*theobroma cacao*,) both in size and shape, somewhat resembles a young cherry-tree, but separates into four or five stems. The leaves are about four inches in length, smooth, but not glossy, and of dull green colour. The flowers are saffron-coloured and beautiful. The fruit resembles a cucumber in shape, but is furrowed deep. Its colour, while growing, is green ; but, as it ripens, it changes to a fine bluish-red, almost purple, with pink veins ; or, in some of the varieties, to a delicate yellow or lemon. Each of the pods contains from 20 to 30 nuts or kernels, which, in shape, are like almonds, and consist of a white and sweet pulpy substance, in a parchment-like shell. These are the cacao or chocolate nuts.

Plantations of cacao are numerous on the banks of the river Magdalena, in South America. They are usually formed in morassy situations, and are sheltered from the intense heat of the sun by larger trees, which are planted with them. There are two principal crops of cacao in the year ; the first in June, and the second in December. As soon as the fruit is ripe it is gathered, and cut into slices ; and the nuts, which are, at this time, in a pulpy state, are taken out, and laid in skins, or on leaves to be dried. They have now a sweetish acid taste, and may be eaten like any other fruit. When perfectly dry, they are put into bags, for exportation. Previously to being formed into chocolate, these nuts are generally toasted or parched over the fire, in an iron vessel, after which process their thin external covering is easily separated. The kernel is then pounded in a mortar, and subsequently ground on a smooth warm stone. Sometimes a little arnatto is added ; and, with the aid of water, the whole is formed into a paste. This is put, while hot, into tin moulds, where, in a short time, it congeals ; and in this state it is the chocolate of the shops. In South America and Spain, other modes are adopted : the chocolate is mixed with sugar, long pepper, vanilla, cinnamon, cloves, almonds, and other ingredients, according to the taste of the respective consumers. Edwards was of opinion, that the cakes of chocolate used in England were made of about one half genuine cacao, and the remainder of flour or Castile soap. That from Caraccas is considered the best. By the natives of South America, the chocolate-nuts are used for food. A white oily matter, about the consistence of suet, is also obtained by bruising them, and boiling the pulp. The oil is by this means liquified, and rises to the surface, where it is left to cool and congeal, that it may easily be separated. This, which is called *butter of cacao*, is without smell, and, when fresh, has a very mild taste. Its principal use is as an ingredient in pomatums. From the nuts, when slightly roasted, oil is sometimes obtained by pressure.

CACTUS Cochinillifer, the plant which supports the cochineal insect. In Mexico and Brazil, the cactus tuna is the favourite food of the cochineal; and in the West Indian Islands, where the cactus tuna is, perhaps, less frequent, the cactus cochinillifer is employed, and answers the purpose sufficiently well. It increases readily, by having the joints stuck into the ground; and the plant loves dry and barren spots. If cultivated for the purpose of rearing the coccus, it must be defended from storms and winds by sheds placed to windward. It blossoms all the year.

The cochineal insect, which feeds upon it, produces the dye which bears its name, and carmine; and is the coccus cacti of Linnæus, a small insect of the order hymenoptera, having a general appearance not very dissimilar to that of the Mealbug of our gardens, and equally covered with a white powdery substance. The male is winged. It is originally a native of Mexico, and was cultivated by the natives, for its dye, long before the conquest of that country. The plantations called Nopaleros are most extensive in the Misteca and Oaxaca, and the latter district alone has exported, according to Humboldt, upon the average, 32,000 arobas annually, estimated at 2,400,000 piastres, above 500,000*l.* sterling. Sloane states, that though the plant be a kind of prickly pear, it has no thorns. In these small plantations or enclosures, they cultivate either the fine sort (*grana fina* of the Spaniards) or the common kind (*grana sylvestre*,) which differ, by the first having a finer quality, and more powdery covering, whilst the latter has a cottony covering.

Placing the females, when big with young, upon the cactus, is called the sowing. The proprietor of a Nopalery buys, in April or May, the branches or joints of the *tunas de Castilla*, which are sold in the markets of Oaxaca, at about three francs a hundred, loaded with semilla. These are kept in cellars for 20 days, when they are exposed to the air, suspended under a shed. So rapid then is the growth of the insect, that, by August or September, the females are big with young, and ready for the sowing, which is done in small nests, made of the fibrous parts of the foliage of a tillandsia, called paxtle. In four months, from the time of sowing, the harvest commences. The insects are brushed off, with a squirrel's or deer's tail, by women. After being gathered, the insects are *killed by boiling water*; or by exposing them in heaps to the sun; or suffocated, by means of *vapour-baths*; and, when dry, they are fit for exportation for the gew-gaw of red and scarlet dyes!

Bancroft estimates the annual consumption of cochineal, in Great Britain only, at about 750 bags, or 150,000 lbs., worth 275,000*l.* The only kind of cochineal that has been conveyed to the East Indies is the sylvestre, from Brazil; and the East India Company have offered a reward of 6000*l.* to any person who introduces the more valuable sort.

The plant and insects are to be seen in Kew-Gardens. The insects are so small that a single yard of scarlet cloth requires the destruction of a thousand. They are curiously formed, and are very interesting and inoffensive in their habits.—*Curtis's Bot. Mag.*

CADMIUM, is found with zinc, and is like tin. Its sp. gr. is from 8·6 to 8·7. Its oxide is a light brown powder.

CALCIUM, the metal of which lime is the basis, and an alkaline oxide. It is a white metal, and is convertible into quick-lime, by being heated in the air. With carbonic acid, it forms limestone, chalk, spar, and marble; with sulphuric acid it forms gypsum, selenite, &c. Under these names and changes it is a most extensive substance.

CAISSON, is a structure used in the construction of bridges, large enough to contain an entire pier, which is built in it; the caisson is then sunk to the bed of the river, and the sides removed from the bottom, which is left as a foundation for the pier.

Floating vessels, under the same name, are used to close the entrances of docks and basins. A groove is worked in the masonry of the entrance, and a vessel of the shape of the opening, with a projection corresponding to the groove, a hanging scuttle on each side, and furnished with pumps, is floated into it at high-tide. The scuttles being opened, the caisson sinks, and fills up the groove. The skuttles are then shut, and the water is prevented from entering the dock, or from discharging itself from the basin. If the dock is to be filled, the scuttles are opened, till the water is nearly on a level on each side, when the scuttles are again shut, the caisson emptied by the pumps, and then floated off.

A patent was lately obtained for the construction of piers, harbours, breakwaters, docks, aqueducts, foundations, embankments, mill-dams, rivers, &c. with "metallic caissons." The caisson is a hollow metallic box, open generally both at the top and bottom; the thickness of its sides is proportioned to the strength and gravity required; and the caissons are united together by dovetails. In works of considerable extent, it is recommended that the caissons be seven feet long, five feet deep, and from two to five feet wide: the width being regulated by the solidity required. In raising one tier of caissons above another, each tier is united to those immediately below and above it, by commencing the alternate vertical courses with a half caisson. The caissons intended for foundations are closed at the bottom. In common dock or canal-banking, the thickness of the front and back of the caissons need not exceed one inch; half that thickness is sufficient for the sides; in works exposed to a heavy sea, caissons of greater thickness may be adopted. The interior of the caissons, after they are erected, is to be filled with liquid lime and rubble, wet sand, or other suitable material, to be found on the spot, so as to form a solid mass, girt with metal. The patentee states, that various calculations of the comparative expense of granite and cast-iron caisson work, show an advantage in favour of his caissons of from 20 to 50 per cent. and upwards; and that walls constructed of caissons can be erected in one-fifth of the time required to build them with stone. The latter circumstance is obviously of very great importance, in reference to coast works.

CAJEPUT OIL, is a volatile oil, obtained from the leaves of the cajeput-tree. The tree is common on the mountains of Amboyna, and the other Moluccas. Oil is obtained, by distillation, from the dried leaves of the smaller variety. It is prepared, in great quantities, in Banda, and sent to Holland in copper flasks. It is of a green colour, very limpid, lighter than water; smell resembling camphor, and of pungent taste. It burns away, without any residuum. It is often adulterated with other essential oils, and coloured with the resin of milfoil. In the genuine oil, the green colour depends on copper, for, rectified, it is colourless.

CALABASH-TREE, *(crescentia cujeta,)* is a production of the West Indies and South America, about the height and dimensions of an apple, with crooked horizontal branches, wedge-shaped leaves, pale-white flowers, and a roundish fruit, from two inches to a foot in diameter. The uses to which the fruit of the calabash-tree is applied are very numerous. Being covered with a greenish-yellow skin, which encloses a thin, hard, and almost woody shell, it is employed for various kinds of domestic purposes.

CAKES.—In making these domestic luxuries, the currants should be well washed, dried in a cloth, and then set before the fire. If not quite dry they will make the cake heavy; and the cake will be lighter if flour be thrown on the currants, and then shaken. The eggs should be beaten very long, the whites and the yolks apart, after which, they must be strained. The sugar should be rubbed to a powder, on a clean board, and sifted through a fine hair or lawn sieve. The lemon-peel should be pared quite thin, and beaten, with a little sugar, in a marble mortar, to a paste; and then mixed with a little wine or cream, so as to mix easily. The lightness of the cake greatly depends on all being well incorporated. When yeast is used, in either black or white plumb-cakes, they require less butter and eggs, and yet are equally light and rich. The oven should be quick, but if too quick, put some paper over the cake.

*To make a rich Plum-cake.*—Take 1 lb. of fresh butter, 1 lb. of sugar, 1½ lb. of flour, 2 lbs. of currants, a glass of brandy, 1 lb. of sweetmeats, 2 oz. of sweet almonds, 10 eggs, ¼ oz. of allspice, and ¼ oz of cinnamon. Melt the butter to a cream, and put in the sugar. Stir it till quite light, adding the allspice and pounded cinnamon; in a quarter of an hour take the yolks of the eggs, and work them in, two or three at a time; and the whites of the same must, by this time, be beaten into a strong snow, quite ready to work in; as the paste must not stand to chill the butter, or it will be heavy, work in the whites gradually; then add the orange-peel, lemon, and citron, cut in fine stripes, and the currants, which must be mixed in well, with the sweet almonds. Then add the sifted flour and glass of brandy. Bake this cake in a tin hoop in a hot oven for 3 hours, and put 12 sheets of paper under it to keep it from burning.

*To make a rich Seed-cake.*—Take 1¼ lb. of flour well dried, 1 lb. of butter, 1 lb. of loaf-sugar, beat and sifted, 8 eggs, and 2 oz. of carraway-seeds, one grated nutmeg, and its weight in cinnamon. Beat the butter into a cream, put in the sugar, beat the whites of the eggs and the yolks separately, then mix them with the butter and sugar. Beat in the flour, spices, and seed, a little before sending it away. Bake it two hours in a quick oven.

*To make a plain Pound-cake.*—Beat 1 lb. of butter in an earthen pan until it is like a fine thick cream, then beat in 9 whole eggs, till quite light. Put in a glass of brandy, a little lemon-peel shred fine, then work in 1¼ lb. of flour; put it into the hoop or pan, and bake it for an hour. A pound plum-cake is made the same with putting 1½ lb. clean washed currants and ½ lb. of candied lemon-peel.

*To make Queen-cakes.*—Take 1 lb. of sugar, beat and sift it, 1 lb. of well-dried flour, 1 lb. of butter, 8 eggs, and ½ lb. of currants washed and picked; grate a nutmeg and an equal quantity of mace and cinnamon, work the butter to a cream, put in the sugar, beat the whites of the eggs 20 minutes, and mix them with the butter and sugar. Then beat the yolks for half an hour and put them to the butter. Beat the whole together, and when it is ready for the oven, put in the flour, spices, and currants : sift a little sugar over them, and bake them in tins.

*To make Banbury-cakes.*—Take 1 lb. of dough made for white bread, roll it out, and put bits of butter upon the same as for puff-paste, till 1 lb. of the same has been worked in ; roll it out very thin, then cut it into bits of an oval size, according as the cakes are wanted. Mix some good moist sugar with a little brandy, sufficient to wet it, then mix some clean washed currants with the former, put a little upon each bit of paste, close them up, and put the side that is closed next the tin they are to be baked upon. Lay them separate, and bake them moderately, and afterwards, when taken out, sift sugar over them. Some candied peel may be added, or a few drops of the essence of lemon.

*To make common buns.*—Rub 4 ozs. of butter into 2 lbs. of flour, a little salt, 4 ozs. of sugar, a dessert spoonful of carraways, and a tea spoonful of ginger ; put some warm milk, or cream, to 4 table spoonsful of yeast ; mix all together into a paste, but not too stiff ; cover it over and set it before the fire an hour to rise, then make it into buns, put them on a tin, set them before the fire for a quarter of an hour, cover over with flannel, then brush them with very warm milk, and bake them of a nice brown in a moderate oven.

*To make cross-buns.* Put $2\frac{1}{2}$ lbs. of fine flour into a wooden bowl, and set it before the fire to warm ; then add a $\frac{1}{2}$ lb. of sifted sugar, some coriander seed, cinnamon, and mace, powdered fine ; melt $\frac{1}{2}$ lb. of butter in half a pint of milk : when it is as warm as it can bear the finger, mix with it 3 table-spoonsful of very thick yeast, and a little salt ; put it to the flour, mix it to a paste, and make the buns as directed in the last receipt. Put a cross on the top, not very deep.

CALABASH-TREE. The pulp is used in diarrhœa, dropsy, and head-ache ; also externally in burns, and in *coups de soleil.* The expressed juice is purgative, and a pectoral syrup is also made from it.

CALAMANDER, is the name of a very beautiful and hard wood of Ceylon, but scarce and dear.

CALCAREOUS SPAR, is crystallized carbonate of lime, in 12 or 1300 several forms, with a rhomboid fracture whose constant angles are 105° 5′ and 74° 55′. Its constituents are 56 lime, and 44 carbonic acid.

CALCAREOUS TUFA, is the lime deposited from water, in the petrifaction of leaves, &c. In many places it forms immense deposits of rocks, well adapted to building because it hardens by exposure, and is so porous as to be readily cut by carpenters' tools.

CALCEDONY, a semi-transparent stone, similar to agate, but clear. Varieties of it are sardonyx, cornelian, prase, plasma, and onyx.

CALC-SINER, or stalactite of carbonate of lime, is the oozing through rocks, or into vacant spaces of the lime-water, which forms calcareous spar. When it falls into vacant spaces, as caves, it hardens as it falls, and forms the cone-like icicles called Stalactites, which, when fractured, present the usual rhomb of calcareous spar. It is the same as the alabaster of the ancients, and a deposit of lime in aqueous solution.

CALENDAR ; the division of time into years, months, weeks, and days ; also a register of these divisions. The periodical occurrence of certain natural phenomena gave rise to the first division of time. The apparent daily revolution of the starry heavens, and the sun about the earth, occasioned the division into days. The changes of the moon, which were observed to recur every 29 or 30 days, suggested the division of time into months. The Greeks were the first who attempted to adjust the courses of the sun and the moon to each other. For this purpose, they reckoned $12\frac{1}{2}$ revolutions of the moon round the earth for one solar year ; and, to avoid the fractions of a month, they made the year consist of 13 and 12 months alternately. Meton and Enctemon finally succeeded in bringing it to a much greater degree of accuracy, by fixing on the period of 19 years, in which time the new moons return upon the same days of the year as before, (as 19 solar years are very nearly equal to 235 lunations). This mode of computation, first adopted by the Greeks (433 B. C.), was so much approved of, that it was engraven with golden letters. Hence the number, showing what year of the moon's cycle any given year is, is called the *golden number.* In the number of days, the Greeks made it $365\frac{1}{4}$. To dispose of the quarter of a day, it was determined to intercalate a day every fourth year, between the 23d and 24th of February. This was called an *intercalary* day, and the year in which it took place was called an *intercalary* year, or, as we term it, *leap* year. This calendar continued in use among the Romans until the fall of the empire, and throughout Christendom till 1582. The festivals of the Christian church were determined by it. With regard to Easter, however, it was necessary to have reference to the course of the moon. The Jews celebrated Easter, (*i. e.* the Passover), on the 14th of the month Nisan (or March); the Christians in the same month, but always on a Sunday. Now, as the Easter of the Christians sometimes coincided with the Passover of the Jews, and it was thought unchristian to celebrate so important a festival at the same time as the Jews did, it was resolved, at the council of Nice, 325 A. D. that, from that time, Easter should be solemnized on the Sunday following the first full-moon after the vernal equinox, on the 21st of March. As the course of the moon was thus made the foundation for determining the time of Easter, the lunar cycle of Meton was taken for this purpose; according to which, the year contains 365¼ days, and the new moons, after a period of 19 years, return on the same days as before. In consequence of this, in the 16th century, the vernal equinox had changed its place in the calendar, from the 21st to the 10th; *i. e.* it really took place on the 10th instead of the 21st, on which it was placed in the calendar. In 1582, Pope Gregory issued a brief, abolishing the Julian calendar in all Catholic countries, and introduced in its stead the one now in use, under the name of the *Gregorian* or *reformed calendar*, or the *new style*, as the other was then called the *old style*. Ten days were dropped after the 4th of Oct. 1582, and the 15th was reckoned immediately after the 4th. Every 100th year, which, by the old style, was to have been a leap-year, was now to be a common year, the 4th excepted; *i. e.* 1600 was to remain a leap-year, but 1700, 1800, 1900, to be of the common length, and 2000 a leap-year again. In this calendar, the length of the solar year was taken to be 365 days, 5 hours, 49 minutes and 12 seconds. Later observations of Zach, Lalande, and Delambre, fix the average length of the tropical year at about 27 seconds less; but it is unnecessary to direct the attention of the reader to the error arising from this difference, as it will amount to a day only in the space of 3000 years. Notwithstanding the above improvement, the Protestants retained the Julian calendar till 1700, when they also adopted the new style, with this difference, that they assigned the feast of Easter to the day of the first full moon after the *astronomical* equinox. But this arrangement produced new variations. In 1724 and 1744, the Easter of the Catholics was eight days later than that of the Protestants. On this account, the Gregorian calendar was finally adopted, 1777 in Germany, in England in 1752, and in Sweden in 1753. Russia only retains the old style, which now differs 12 days from the new.

CALENDERING takes wrinkles from cloth, compresses the threads, and produces a bright polish. Bramah's water-press is commonly used with a power of 400 tons, and pasteboard rollers compressed in discs into the density of silver. A feeble species of calendering is mangling, used to confer glaze on washed linens. Another species is hot and cold pressing, much used in restoring the surface of paper, after being wetted for printing. Packing is another branch, by which goods are conveyed in the least space without damage.

CALIBER; the interior diameter of the bore of any piece of ordnance, or the diameter of a shot or shell.—*Caliber*, or *caliper compasses*, are a sort of compasses with arched legs, used in the artillery practice, to take the diameter of any round body, particularly of shot or shells, the bore of ordnance, &c. The instrument consists of two thin pieces of brass, joined by a rivet, so as to move quite round each other. It contains a number of tables, rules, &c. connected with artillery practice.

CALICO; white cotton cloth, which derived its name from Calicut, a port of India, from which it was first brought. Calico-printing is a combination of the arts of engraving and dyeing, and is used to produce, upon woven fabrics, chiefly of cotton, a variety of ornamental combinations, both of figure and colour.

In this process, the whole fabric is immersed in the dyeing liquid; but it is previously prepared in such manner, that the dye adheres only to the parts intended for the figure, while it leaves the remaining parts unaltered. In calico-printing, adjective colours are most frequently employed.

The cloth is prepared by bleaching, and other processes, which dispose it to receive the colour. It is then printed with the mordant, in a manner similar to that of copper-plate printing, except that the figure is engraved upon a cylinder instead of a plate. The cylinder, in one part of its revolution, becomes charged with the mordant, mixed to a proper consistence with starch. The superfluous part of the mordant is then scraped off by a straight steel edge, in contact with which the cylinder revolves, leaving only that part which remains in the lines of the figure. The cloth then pasess in forcible contact with the other side of the cylinder, and receives from it a complete inpression of the figure, in the pale colour of the mordant.

The cloth is then passed through the colouring-bath, in which the parts previously printed become dyed with the intended colour.

CALOMEL, is made by triturating in

a mortar 4 of corrosive sublimate, with 3 of quicksilver, till quite mixed. In a mattrass, with great heat, a sublimation of the calomel takes place. It should then be washed and dried for use. Its sp. gr. is 7·176. It is a valuable purgative, alone, or mixed, in pills of from 2 to 4 grains of calomel.

*Calomel pills.* Mix 2 drs. of gum guaiacum with 1 dr. of calomel, and of precipitated sulphate of antimony with balsam of capivi.

CALORIC, is a term used in modern books, for all phenomena of heat, or atomic motion. It is one of the fancies of theory, for there is no heat distinct from atomic motion, taken in an enlarged and accurate sense. Of course, there is no fluid to squeeze in and out of bodies corresponding to the ideas about caloric, and, in fine, no caloric except in imagination. When a smith strikes a piece of iron, and makes it red hot, he does not squeeze caloric out of it, but he puts its atoms in motion, imparting to them the momenta of his hammer. This may be made evident, by feeling its vibrations after one or two blows, by smelling the radiations, or by rendering them visible in putting some water on the hot iron, and beholding the radiations of its atoms as steam accompanied by the cooling of the iron. All this has nothing to do with squeezing out caloric. The fibres of the iron, thus driven together, will not vibrate again till they have been re-expanded by heat, and hence the necessity of placing it in the fire, before another hammering. Rubbing two sticks together also produce heat, *i. e.* motion sufficient to set them on fire, and so with all cases of friction, or percussion. He must have an intoxicated imagination, who refers the effects to any thing but the motions of the atoms. Then, as fluidity and gassification are effects of the same motions, whatever diminishes the volumes causes part of the motion to leave the condensed fluid, or gas, and display heat. To imagine any thing never seen, as being concerned, is to deprive philosophy of one of its best laws, and of all its reality. In the case of boiling water on a fire, if the heat from the blacksmith's hammer had been so directed as to convert oxide of manganese into oxygen, and this were made to support the fire, we should see that the boiling of water required no other origin than the said smith's blows, or the momenta of the hammer. Capacity for heat means nothing more than the greater facility with which some bodies receive and transmit motions than other constructions of other bodies, depending on their continuity, density, dispersion, irradiation, &c. Expansion by heat, means merely that the motion imparted places the atoms at a greater distance in some condition of motion.

It might seem to be wrong, to devote arguments to prove the non-existence of what never was weighed, or measured, or felt, or seen; but no higher proof of the infatuation of theory can be adduced, than that the word *caloric* fills in one place, 36 closely-printed pages of the last edition of the valuable dictionary of Ure. It reminds those who turn them over, of the Aurora of Jacob Behmen. All facts relative to heat, or atomic motion, are brought within this mystical caloric of the other Scotch professor, Black, whom 20 other Scotch professors, and indefatigable writers, agree in illustrating. Nationality in matters of science is to be lamented.

CALUMBA ROOT, is a valuable stomachic, neither astringent nor stimulating, and may be taken as powder, or infusion, and as required may be combined with purgatives or aromatics. Dr. Paris states, that tinged white briony is often sold for it.

CALX, is the ancient name of metals burnt in air, and converted into what are now called *oxides*; but it is still retained in the case of lime, which, when reduced to metal, by expelling its oxygen, is called *calcium*. This when oxidated again becomes lime, and is called carbonate of lime, but by analogy is oxide of calcium. The effects are anomalous, for if carbonate of lime is heated to drive off the oxygen, or carbonic acid, as it is called, it does not form calcium, but the caustic alkali called quicklime, and further heat would convert it into a vitrified substance, or glass, but not into the metal calcium. Nevertheless, the conversion, as far as it proceeds, proves that the metal is a pure alkali, like all metals. The vitrification is ascribed to silex, but since all metals vitrify, as in the slag of iron, &c. are we to conclude that all contain silex? If so, it points to the origin of metals in the way indicated.—*See* METALS.

CALX, is obtained *pure*, by treating marble with muriatic acid, ammonia, and sub-carbonate of potass, when it is still a compound of calcium and oxygen. The substances called calxes are chalk, limestone of several varieties, as pea-stone, roe-stone, marbles, dolomite, fibrous spar, stalactite, &c. &c. Lime-stones are also known as compact, foliated, or leafy, and fibrous. They effervesce with acids, and are about two-thirds lime. Chalk is used in medicine, instead of the filthy preparation of crabs' claws, and eyes of crawfish!

CAMBOGE, is the basis of several worm medicines, as the specific of Herrenschwad, which is 1 of camboge and 2 of subcarbonate of potass, or the spirit of scurvy grass is a solution of camboge in the compound spirit of armoraciæ, or the specific of Clossius.

CAMBLET, the name of hair, wool, or silk stuff, sometimes varied in the warp and woof, and figured or waved by pressing.

CAMBRIC, fine linen, made of the best white flax.

CAMERA LUCIDA, is a piece of plain glass set at an angle of 45°, when it reflects objects before it on a sheet of paper placed beneath, so as to enable any one to draw them in true perspective.

CAMEL, is the name of vessels sunk by water, and fastened to the sides of a ship of great draft of water, and then the water being pumped out of the camels, they rise and lift the ship a few feet, so as to enable it to pass over any shoal or sand-bank. They are used in passing bars, &c.

*Camel's Hair*, in the east and the Levant, is an important article. Hats of superior quality are made of it, far more durable than beaver. It is also used for tent-cloth, carpets, and coarse apparel. French hats, made of black camels' hair, are in great request.

CAMWOOD, is brought from the African coast, and is used as a red dye.

CAMPHOR, is a white, resinous production, of peculiar and powerful smell, extracted from two or three kinds of trees of the bay tribe, that grow in the Eastern Archipelago. Of these, the principal is the *laurus camphora*, of considerable height, and the trees yield from 12 lbs. to 20 lbs. each. Camphor is found in every part of the trees; in the interstices of the perpendicular fibres, and in the veins of the wood, in the crevices and knots, in the pith, and in the roots, which afford by far the greatest abundance.

The method of extracting it consists in distilling with water in large iron pots, which serve as the body of the still, with earthen heads fitted to them, stuffed with straw, and provided with receivers. Most of the camphor becomes condensed in the solid form among the straw, and part comes over with the water. Its sublimation is performed in low, flat-bottomed glass vessels, placed in sand, and the camphor becomes concrete, in a pure state, against the upper part, whence it is afterwards separated with a knife, after breaking the glass.

Numerous other vegetables are found to yield camphor by distillation.—Among them are thyme, rosemary, sage, elecampane, anemone, and pusatilla. A smell of camphor is disengaged when the volatile oil of fennel is treated with acids; and a small quantity of camphor may be obtained.

It is a valuable stimulant, and narcotic, acting as a sedative on the nerves. The dose is from 2 gr. to 1 scr., and it varies its effects according to dose and mode of exhibition, usually in mucilage or magnesia. Made into a pill with opium, it allays the pain of a hollow tooth. It is also an excellent addition to ammonia, bark, calomel, and other medicines in various diseases.

Camphor has a bitterish, aromatic taste, is unctuous to the touch, and possesses a degree of toughness, which prevents it from being pulverized with facility, unless a few drops of alcohol be added, when it is easily reduced to a powder. It floats on water, and is exceedingly volatile, being gradually dissipated in vapour if kept in open vessels. At 288° Fahr. it enters into fusion, and boils at 400° Fahr. It is insoluble in water, but is dissolved freely by alcohol, from which it is immediately precipitated, in milky clouds, on the addition of water. It is likewise soluble in the fixed and volatile oils, and in strong acetic acid. Sulphuric acid decomposes camphor, converting it into a substance like artificial tannin. With nitric acid, it yields a peculiar acid, called *camphoric acid*. This acid combines with alkalies, and forms peculiar salts, called *camphorates*. They have not hitherto been applied to any useful purpose.

As an internal medicine, camphor has been employed, in doses of from 5 to 20 grs., with much advantage, to procure sleep in mania, and to counteract gangrene. In large doses, it acts as a poison. Dissolved in acetic acid, with some essential oils, it forms aromatic vinegar. It promotes the solution of copal. Its effluvium is very noxious to insects.

*To make Compound Camphor Liniment*, or *Ward's Essence, for the Tooth-ache.*—With 12 oz. of spirit of lavender, mix 6 oz. of caustic ammonia; reduce to 12 oz., and add 2 oz. of camphor.—Or, dissolve 2 oz. of camphor in 10 of spirit of lavender, and 12 of caustic ammonia.

*Camphor, Compound Liniment of*, is camphor 2, liquid ammonia 6, spirits of lavender 16; which is Ward's Essence for the Head-ache. Camphor liniment is camphor 1, olive-oil 4.

*Compound Tincture of Camphor*, is made by mascerating for a fortnight 2 scruples of camphor, a drachm each of purified opium and benzoic acid in a quart of proof spirit. It resembles paregoric elixir.

*Camphor Spirit*, or tincture, useful in chilblains and rheumatism, is merely 1 or 2 oz. of camphor dissolved in a pint of rectified spirits.

*Camphoric Acid*, is made by distilling camphor with nitric acid.

CAMPHIRE, is the product of many vegetables, as *Rough Camphire* obtained from the roots and shoots of the *Laurus camphora*, by distillation with water.

*Dryobalanus Camphire* is obtained by merely splitting the Dryobalanus camphora; the heart of this tree containing camphire.

*Refined Camphire* is made by sublimation with one-sixteenth its weight of lime, in a very gentle heat. Camphire is stimulant, narcotic, and diaphoretic. Camphire is put into boxes to keep insects from them, and is used in fire-works. It renders copal soluble in some essential oils in cleaning pictures.

*Rosemary Camphire*, from the oil, by a careful re-distillation of one-third of the oil; the residuum affords crystals of camphire; on separating which, and re-distilling the remaining oil two or three times, the whole of the camphire, 1 oz. from 10 of the oil, may be obtained.

*Sweet Marjoram Camphire*, about 1 oz. from 10 of the oil; not volatile. *Sage Camphire* yields 1 oz. from 8.

*Lavender Camphire* gives 1 oz. from 4 of oil.

*Thyme Camphire*, crystals cubical, and precipitated from nitric acid in a glutinous mass.

*Soap Camphire* is made from soaps, by solution in water, adding muriatic acid, collecting the curd, washing it with boiling water, and pressing it to separate the liquid oleine. It is a mixture of stearic and margaric acids, and is used to make candles, which are very white, as neat as wax-candles, and give a brighter light.

*Turpentine Camphire* is made from spirit of turpentine, by passing muriatic gas through it, by which it will yield about its own weight of artificial camphire.

*Citron Camphire*, made from the white rectified oil of citrons. If exposed to muriatic acid gas, it absorbs 286 times its bulk, or nearly half its weight, and yields about 9-10ths of camphire.

*The* CAMPHIRE TREE, whose roots yield camphire by distillation.—*See* CAMPHOR.

CANALS, are important artificial communications, always at a level, without any opposing current, and provided with every facility for rapid, cheap, and certain conveyance. They are of great antiquity in China, Egypt, and the Netherlands, but of modern date in England, the first not being above 60 years old. They spread in the prosperous years 1791–2, when capital sought employment, and when public confidence had not been abused by government. There are now nearly 100 in the United Kingdom, connecting all the great marts of industry, and centres of great population. The United States vie with us in number and extent, and France also has many. Holland is intersected with them. Their slow rate of travelling has lately been removed, by applying 2 horses to passage-boats. There are also various patents for the application of steam to the barges, which have been improved by making them of iron instead of timber.

Rail-roads and steam-carriages promise still further facilities of conveyance. It is canals and such works that are the true capital of a civilized and improving country.

CANCER, has been treated, with doubtful success and sometimes fatal results, with arsenical preparations. Justamond's was 2 antimony, 1 arsenious acid, fluxed, and levigated with opium. Plunkett's was arsenious acid, sulphur, flowers of ranunculus, flammula and cotula fœtida, made into paste with the white of an egg, and applied, *air-tight*, on bladder or caoutchouc. Davidson's was arsenious acid and hemlock. Perhaps the total exclusion of air, as the pabulum of all eruptious and ulcers, is the chief remedy.

CANDIED HOREHOUND. Mix one pint of horehound juice with 6 lbs. of brown and 4 of white sugar.

CANDLES, arrangements of a combustible material, with a wick, to raise it in the air. The best are made of half sheep's and half bullock's fat. When thoroughly melted and skimmed, and 3 dips made to cover the wick, water is poured upon it to precipitate impurities. It is then passed through a coarse hair-sieve, and remains many hours fit for dipping, either as dips or moulds. In wax-candles the wicks are waxed stiff; they are then suspended over a vessel of melted wax, which is poured over them with a ladle lower and lower. They are then rolled and polished on a smooth table. 10 to the lb. of tallow mould-candles burn 5 hours, dips $4\frac{1}{2}$ hours; 4 to the lb. moulds, $9\frac{1}{4}$ hours. An argand lamp of purified linseed or colza oil gives $3\frac{1}{2}$ times more light than a 4-candles, with about 4 times the weight of oil.

Candles, hitherto made of tallow, wax, and spermaceti, are beginning to be superceded by the more efficacious and agreeable light of cocoa-nut, now made into candles in London, and in extensive consumption. Besides the American cocoa-nut as a substitute for tallow, palm-oil is imported from Africa in large quantities, for similar purposes.

It appears probable that these new

and cleaner products will in a few years render us quite independent of Russia, &c. in the article of tallow, &c.

The myrtle-berry wax of North America is also preferred to bees-wax and spermaceti, as more fragrant, with a clearer light.

For lamps, the purified vegetable oils of France exceed any in the world in the whiteness and the quantity of light, as well as in economy.

If the cotton wick is steeped in lime-water, in which is dissolved a considerable quantity of the nitrate of potassa, a purer flame and a superior light is obtained; a more perfect combustion is insured; snuffing is rendered nearly superfluous, and the candles do not run. But the wicks should be thoroughly dry, before the tallow is put to them.

Count Rumford states, that the relative weight of the undermentioned inflammable substances, required to produce an equal degree of light, is as follows:—

| | |
|---|---|
| A good wax-candle, kept well snuffed, and burning with a clear bright flame | 100 |
| A good tallow-candle, kept well snuffed, and burning with a bright flame | 101 |
| The same tallow-candle, burning very dim for want of snuffing | 229 |
| Olive-oil, burnt in an argand's lamp | 110 |
| The same burnt in a common lamp, with a clear bright flame, without smoke | 129 |
| Rape-oil, burnt in the same manner | 125 |
| Linseed-oil, burnt in the same manner | 120 |

Mr. William Palmer, of Wilson-street, has patented improvements in making candles to burn without requiring snuffing, by the following method. He applies to a portion of the strands, about a tenth of them, composing the wick, a quantity of *bismuth*, in a finely-divided metallic state, or else the nitrate, or any other similar preparation of bismuth. The portion of wick thus prepared is to be surrounded with more strands, till it becomes half the thickness required for the wick. It is then to be cut into pieces corresponding in length with twice that of the candle for which it is intended. The wick is next twisted spirally round a thick steel wire, in contrary directions. A notch is made in the lower end of the wire, to receive the middle of the wick, and the upper end is bent into a rectangular loop, to retain the two ends of the wick together, and to facilitate its removal when the making of the candle is completed, which is to be effected either by moulding or dipping, in the usual manner. The combustion of the wicks of candles manufactured in this manner, with a portion of bismuth in combination with the wick, made of the double spiral form, that the two pieces may, in the act of burning, curl over to different sides, where they will be accessible to an additional quantity of oxygen, and the combustion will be so intense as to leave no carbonaceous matter to impede the light, or to require removal by snuffing.

Mr. John White has obtained a patent for a method of making candles, whose outer surface, being less fusible than the interior mass, serve as a vessel to contain it. The moulds used by him for manufacturing his candles are a drawn or hollow tube. He then melts as much wax, spermaceti, tallow, or any other material or compound fit for, or adapted to, the making of candles, as is equal to fill one-third of the mould, or any such quantity as may suit the fancy. When the material is poured into the mould in a fluid state, he immediately lays the mould down lengthways, and keeps it constantly going round until the material inside of the mould is fixed or congealed round the side of the mould. Thus a case or hollow cylinder will be formed from the fluid material very true, and exactly the size, shape, and length of the mould. This case, or cylinder, when discharged from the mould, forms the outside of the intended candle, which may be cottoned and filled up at pleasure, in the usual way, with some material of greater fusibility, which forms a regular candle.

The patentee avers, that candles manufactured by this means can be made to look superior to wax, and vary in price according to quality, from a little more than the price of tallow to two-thirds of the price of wax, and answer all the purposes of wax-candles, not requiring snuffing, afford equal or superior light without having a greasy appearance, and acquire a fine high polish by friction; may be used in any weather or climate without losing their solidity, polish, or beauty, and completely removes the disagreeable smell and feel arising from the use of tallow-candles.

CANKER. The cause of canker in trees is very similar to the cause of the scurvy in man; it is either a defect of the blood or blood-vessels; in trees, it is generally the defect of the latter, as it is never the ascending sap which causes it, but always the descending sap, which is obstructed in its passage to the root. A wet autumn causes a superabundance of sap in the leaves, which being forced to return in an undigested state, the pores are too contracted to admit it in a regular way, and it forces new channels in the bark; the first frosty night converts such streams into ice, and they become what Forsyth calls "small dots, as if made with the point of a pin." Midsummer pruning is a good preventive.

The causes are—bad or wet soil, and subsoil; exposure to cold bleak winds, in high situations; stricture of the bark; frost checking the circulation of the sap; external injuries of different kinds; insects under the old bark; old age, improper stocks, or improper grafting. Mr. Knight thinks that no topical application will do any good, and that the disease is not of the bark but of the wood.

CANNON, a heavy metallic gun, which is moved by the strength of men and horses. It is mounted on a carriage, and iron (formerly stone or leaden) balls are projected to a distance from it by the force of gun-powder. The interior of the cannon is called the *bore*. The solid piece of metal behind is named the *breech*, and terminates in the *button*. The *dolphins* (so called because they used to be made in the form of that animal) are the handles by which the piece is mounted or dismounted. The aperture through which the fire is introduced into the bore, to ignite the charge, is called the *vent* or *touchhole*, in which a small tube, used to contain the priming, is placed previous to firing. The supports, which are denominated *carriages*, are mounted on trucks, as in the case of ship-guns or garrison-guns, or on two wheels, as in the case of field-pieces.

When a field-piece is to be moved, a two-wheeled frame is fixed to the carriage, which is called a *limber*, and this process is called to *limber up*. The charge, or cartridge, is a bag filled with powder, carried near the cannon. The cannon is fired by means of the *match*, which is a lighted bunch of tow, wound round a small stick; or by a tube, filled with the priming-powder, from which a piece is broken off every time, and forced into a stick, to light the charge. On board English ships the cannon are fired by means of locks. To perform the labour required in managing cannon, is called, to *serve the guns*.

Cannons are, at present, named from the weight of the balls which they carry, 6-*pounders*, 12-*pounders*, &c. &c. The length of the cannon is in proportion to the *caliber*. Before their invention, machines were used for projecting missiles by mechanical force. These were imitated from the Arabs, and called *ingenia*; whence *engineer*. The first cannon were made of wood, wrapt in numerous folds of linen, and well secured by iron hoops. They were of a conical form, widest at the muzzle. Afterwards, they received a cylindrical shape. At length they were made of iron bars, firmly bound together, like casks, by iron hoops. In the second half of the 14th century, they were formed of an alloy of copper and tin, and, in process of time, other metals were added.

Charles Millon invented a kind of air cannon, 2 ft. long, 3 inc. diameter in the thickest part, 12 lines caliber, charged with inflammable air, and fired with a Leyden jar, or a piece of cat-skin, by which 12 discharges can be made in a minute. It stands on a frame of glass, and may be directed to any point. In 1740, cannons were made of ice at St. Petersburg, and balls of many pounds weight were projected without injuring the pieces.

A *Cannon-clock* is a contrivance invented by one Rousseau, and placed in the garden of the *Palais Royal*, and in the Luxembourg at Paris. A burning-glass is fixed over the vent of a cannon, so that the sun's rays, at the moment of its passing the meridian, are concentrated, by the glass, on the priming, and the piece is fired. The burning-glass is regulated, for this purpose, every month.

*Cannon-casting*, in iron and brass, a very important manufacture in the large way. The mould is made of sharp dry sand, mixed in paste with water and clay. The model is in pillars of light metal, and a 600th longer than the gun, to allow for shrinking in cooling. The dry sand mould is formed in a cast-iron box, with projections for the trunnions, &c. then well-dried in a stove, and painted black, to prevent adhesion.

CANTHARIDES, are Spanish flies, (one of the old remedies) used for raising blisters. They are often useful, but apt to occasion strangury, which frequently proves fatal. Dry cupping and rubefacients, as cataplasms of capsicum, &c. are therefore preferred by many practitioners.

Cantharides, is an opprobrium on pharmacy and chemistry, and the use of flies may be regarded as similar to that of dead men's bones, viper's broth, baked toads, &c. in the dark ages. Robiquet found the blistering principle to consist of crystalline plates, with a micaceous lustre like spermaceti. Ether and oils dissolve it, and in sweet oils it produces vesication like the Spanish beetles, but it has not been made from the vegetable or mineral kingdom. The dangerous action in the bladder may be averted by first boiling the cantharides, and this does not diminish their vesicatory power.

CAOUTCHOUC. This substance, improperly termed *elastic gum*, and more commonly, from its application to remove pencil-marks from paper, *India rubber*, is obtained from the milky juice of several plants, which are natives of the torrid zone, and is now manufactured to a large extent by the Hancocks, in London, by a secret process. The chief are the *hævea Guianensis*, the *jatropha elastica*, and *urceola elastica*. It is brought from South America and Africa.

It is obtained by making incisions through the bark of the tree, chiefly in wet weather. From the wounds thus formed the juice flows abundantly. It is of a milky-white colour, and is conducted by a tube or leaf, supported by clay, into a vessel placed to receive it. Some writers assert that, on mere exposure to the air, it gradually hardens; and others, that it goes through a certain process for this purpose, which the Indians keep a secret. It is usually brought to Europe in the form of pear-shaped bottles, which are formed by spreading the juice over a mould of clay, exposing it to a dense smoke, or to a fire, till it becomes so dry as not to stick to the fingers, when, by certain instruments of iron or wood, it is ornamented on the outside with various figures. This done, the clay in the inside is moistened with water, and picked out. It is remarkable for the flexibility and elasticity which it acquires on attaining a solid state, and also for the numerous useful purposes to which it is capable of being applied. By the Indians, it is sometimes formed into boots, and bottles are made of it, to the necks of which are fastened hollow reeds, through which the liquor contained in them can be squirted at pleasure. Flambeaux are likewise formed, which give a very brilliant light; and it is said that a torch of it, an inch and a half in diameter, and 2 ft. long, will burn 12 hours. The inhabitants of Quito prepare a species of cloth with the hardened juice of this tree.

In its solid state, caoutchouc is of a close texture, distinctly fibrous, of a light-brown color, or sometimes nearly white. Its elasticity is such that it can be stretched to a great extent: and, on removing the stretching force, it recovers its original dimensions. Its softness and pliancy are increased by heat. Boiling water renders it so soft, that two slips, newly cut and pressed closely together, may be firmly united. By a greater heat, it is fused, and may, in that state, be applied to the surface of steel instruments, which it will cover with a transparent film, that effectually preserves them from rust. It is insoluble in alcohol and in water. Oil of turpentine softens it, and forms with it a sort of paste, that may be spread as a varnish, but is very long in drying. In truth it never dries, and all that is published about its solution, &c. is very questionable, if not untrue.

Caoutchouc, from its softness, elasticity, and impermeability to water, is applied by Mr. John Hancock to the formation of catheters, bougies, and tubes for conveying gases and liquids. It is also used for over-shoes; and its solution in oils forms a flexible varnish.

Mr. Hancock also makes a great variety of surgical and economical apparatus, as acoustic tubes, enima tubes, socks for shoes, elastic garters, toy-balls, &c. of this curious material.

Caoutchouc is dissolved by boiling spirits of turpentine, and putting in small pieces of caoutchouc till dissolved. Then add half the quantity of linseed-oil, with litharge for drying, and boil together for half an hour. This is a varnish impenetrable to water, but it does not dry. Hence Mackintosh makes cloaks, &c. by a doubling of the cloth. But T. Hancock has a method of reducing it to thin sheets for all kinds of manufacture. The means are secret, but if duly instructed, the Indians might prepare it in thin sheets, as well as in bottles, &c. Its natural colour is white, and it is said to be made black by smoking it.

Caoutchouc and naphtha most nearly resemble each other, the one being 3 atoms of carbon, and 2 of hydrogen; and the other, 2 of carbon and 1 of hydrogen.

Caoutchouc is soluble in sulphuric, but better in nitrous ether, and when spread the ether evaporates. So also naphtha and petroleum. The solution in oil of turpentine remains glutenous. When distilled, it yields ammonia and carburetted hydrogen. A substance resembling it may be made from very high-drying linseed-oil, which spread then dries like caoutchouc with smooth cut edges; by heat, pressure, and percussion, pieces may be joined to any size, and no seam appear.

CAPER. Capers are the unopened flower-buds of a low shrub, which grows from the crevices of rocks and walls, and among rubbish, in the southern parts of France, in Italy, and the Levant.

In the south of France, the caper-bush is very common. It grows wild upon the walls of Rome, Sienna, and Florence, and, when trained against a wall, flourishes even in the neighbourhood of Paris. It is cultivated, on a large scale, between Marseilles and Toulon, and in many parts of Italy. In the early part of the summer it begins to flower, and the flowers continue successively to appear, until the commencement of winter. The buds are picked every morning, before the petals are expanded; and, as they are gathered, they are put into vinegar and salt. When a sufficient quantity is collected, they are distributed, according to their size, into different vessels; again put into vinegar, and then packed up for sale and exportation.

CAPILLAIRE. In 2 quarts of water boil, well, 6 lbs. of white sugar, add the white of an egg, skim, boil to a syrup, and add, while warm, a quarter of a pint of orange-flower water. *Or*, In 2 gallons of water boil 3 oz. of gum-dragon, strain and add water to make 3 gallons, and 24 lbs. of white sugar; clarify with the whites of 5 eggs, and add 5 half-pints of orange-flower water.

*Or*, boil 8 lbs. of white sugar in a gallon of water, skum, clarify with the white of an egg, when cool add a pint of rose-water, and keep in dry very warm bottles, colour with brandy-colouring when proper. This is an elegant addition to pump-water in summer, and is both nutritive and restorative.

*Or*, simple syrup 1 pint, curaçoa 2 drachms.

CAPILLARY ACTION, is that force with which water and other fluids rise in tubes, or between glass-plates, or around any solid immersed in water, or flowing in it. It arises from the elastic pressure of the atmosphere, and from the interception of that pressure by the boundary side of the solid. The air presses, but the solid does not press.

Capillary action, on fluids in tubes, is inversely as the bore and directly as the length, a law *necessarily* produced by the interception of the atmospheric pressure on the fluid by the glass or other solid. When mercury is the fluid, being denser than the tube or intercepting plate, the pressure raises the tube or plate as to the mercury, and the fluid mercury sinks instead of rising like water, &c. The cause and effect have the plainest connection of any phenomena; yet, owing to ancient superstitions, nothing is more mystified by makers of books and wonders. When a fine tube is dipped in water, the whole air presses on the surface without the tube, but only perpendicularly within the tube, and of course the liquid is mechanically driven up the tube by the difference of force, which difference is inversely as the bore, and directly as the length. No fact or experiment ever contravened this plain deduction.

CAPITAL, in commerce, means the amount of money and credit which can be brought to bear on any establishment or concern of productive industry. National capital implies currency, and in its primary and dormant state it is simple currency. But, in a state of society, in which credit unites time or future payment on transactions with currency, then capital is the union of credit and currency. Capital in this new relation is credit in activity, and may be as much greater in amount than currency, as transactions, to be met progressively in currency, may be greater in amount than currency. Payments are usually so distributed as to accord with the power of the existing currency, and, when not so, as at the beginning of March, much inconvenience is felt for want of currency, on the 4th, to meet 3 days' payments, or before the dividends, when there are heavy payments into the Exchequer. By suitable distribution of payments, 50 millions of currency used to maintain 5,000 millions of transactions, or payments and repayments in the year. Of course, if, as in 1826, the currency were ignorantly reduced from 50 to 30 or 35 millions, the majority of those who were under obligations for part of the 5,000 millions (from 2,500 to 3,000,) could not meet their engagements. Capital therefore is credit, and transactions, as 100, more or less, with currency as 1; and there may be great capital without land, as at Venice, Genoa, &c. or no capital with land, as in Poland, Africa, &c. but never without transactions or credit in productive activity.

CAPSICUM, is the name of the plant whose seeds, in Guiana, &c. produce cayenne-pepper. The seeds grow in a pod. The species called bird-pepper is the best. It is used in medicine as a stimulant, as a tincture, and a gargle, and the tincture may be purchased at the shops.

CAPSTAN, is the axle fixed on the deck of a ship, to raise the anchor, &c. by means of handspikes, or sometimes by a wheel, assisted by pullies.

There are commonly two capstans in large ships; the *main capstan*, placed behind the main-mast. The other is the jeer-capstan, or little-capstan, and stands on the second deck, between the main-mast and the mizen: its use is, chiefly, to heave upon the jeer-rope, or to heave upon the viol, to hold off by when the anchor is weighed; and on other occasions, where less force is required than to weigh the anchors, &c. There is also a *flying-capstan*, which may be moved from place to place, and much used on low shores. The parts of a capstan are, the foot, which is the lowest part; the spindle, the smallest part of which turns round in an iron socket, called the saucer; the whelps, a sort of brackets set into the body of the capstan, close under the bars, and reaching downwards from the lower part of the drum-head to the deck; the barrel, the drum-head, which is a broad cylindric piece of wood fixed above the barrel and whelps, in which are the holes for the bars to be put into; the bars, which are small pieces of timber, by which the men heave; the pins, which are little bolts of iron, thrust perpendicularly through the holes of the drum-head; and through a correspondent hole in the end of the bar, made to receive them when the bars are fixed; the pawls, which are pieces of iron, bolted to one end of the beams of the deck, close to the body of the capstan, but so as that it have liberty to turn about every way; and against them the whelps of the capstan bear; so as that by them the capstan may be stopped from turning back. There are also hanging pawls, which reach from the deck above to the drum-head immediately beneath it; and, lastly, the swifter, which is a rope passed horizontally through holes in the outer ends of the bars and drawn tight, designed to keep the men steady whilst they work, and to afford room for a greater number to work at once.

CARAVAN, is a vehicle on springs, for removing furniture drawn by horses. But, in Asia and Africa, it applies to great companies of itinerant merchants, who travel through those extensive continents with droves of laden camels. They are governed in their movements by a chief or Aga, and their arrival in large cities is distinguished by a fair of their goods, which lasts for some days. They take immense routes, often for months, and extending several thousand miles. They diffuse the productions of different countries to others, and buy and sell as they go. Our fairs arose in like manner, and were in ancient times sustained by itinerant merchants, exactly like the eastern caravans. They have been sunk to insignificance by resident traders in the same articles, and by the facility of intercourse by public carriers from ports and seats of manufacture.

CARBON, is the substance of bodies separated from their volatile and factitious parts. Thus wood, so heated in close vessels as to part with all its volatile parts, becomes charcoal or carbon. This, burnt, combines with the oxygen of the air, and forms carbonic acid gas. It leaves a trifling residuum of a 200th, and the other 199-200ths is carbon. When all is taken up, as in the combustion of the diamond, it is found that 27·6 of carbon unites with 72·4 of oxygen, in forming 100 parts of the carbonic acid gas.

It absorbs various gases in its pores when placed within them, as 90 times its own volume of ammoniacal gas, 40 of nitrous oxide gas, 35 of carbonic oxide and olefiant gas, $9\frac{1}{4}$ of oxygen, $7\frac{1}{2}$ of nitrogen, and $1\frac{3}{4}$ of hydrogen. In 24 hours it absorbs from the air an 8th of its own weight of water. This singular property renders it of extensive use in the arts, in preserving, absorbing, &c. It destroys bad smells, purifies putrid water, absorbs contagious matter, &c. &c.

Carbon varies in its qualities according to the substance from which it is prepared; that of the soft woods, as the willow or alder, is the best for crayons, and for making gunpowder; that of the harder woods is used for fuel, or for a support for substances exposed to the flame of a blow-pipe. Charcoal of animal substances has the greatest clarifying powder. Charcoal made by a low red heat, not exceeding cherry red, has a dull surface, and is best for clarifying liquids, and probably for making gunpowder, or for fuel. If the heat is carried beyond this point, the charcoal acquires a brilliant surface, and is considerably inferior for clarifying, and probably for every other use. The greatest part of carbonaceous residues are used as fuel, or in the manufacture of gunpowder.

Carbon destroys the bitterness of certain bodies. Dr. Kopff made many experiments on different bitter substances, and found great varieties of action. Each experiment was made with 2 ozs. of distilled water, 20 grs. of bitter extract of the particular plant, and about 60 grs. of the recently-pulverized charcoal; they were digested at temperatures from 78° to 86°, and examined at intervals, being compared with similar solutions without the charcoal. Wormwood, centaury, gentian, quassia, were not changed; orange-peel, camomile, yarrow, soapwort, and Iceland moss, lost all their bitterness. Endive, rhubarb, &c. &c. were nearly deprived of their bitterness.

*Oak charcoal*, *Beech charcoal*, *Hazel charcoal*. Pile-burned, are those commonly sold in London for fuel.

*Willow charcoal*. Pile-burned is sometimes found mixed with the common charcoal, and picked out for crayons, to polish copper-plates, tooth-powder, and to put into poultices to correct fetid ulcers.

*Alder charcoal*, *Dog-wood charcoal*, *Spindle-wood charcoal*. These are distilled in iron cylinders for making gunpowder: they must not be allowed to absorb, in cooling, the vapour contained in the receiving vessels.

*Kiln-made coke*, *Stifled coke*. From coal burned in a pile or open kiln; dull black; used as fuel, produces a very strong heat.

*Gas coke*, *Distilled coke*. The remains of the coals used in making gas for lights; bright grey, produces only a weak heat, not sufficient to smelt iron.

Other kinds of charcoal are used as black colours.

*Charbon mineral.* From bituminous slate, burned in covered iron pots, black, easily friable; used to clarify liquids, but is considerably inferior to bone black, and does not abstract the lime from syrup.

Carbon and hydrogen produce several important compounds.

The first species is the gas of our lamps, *carburetted hydrogen*, which consists, when pure, of 1 volume of vapour of carbon, and 2 of hydrogen; their specific gravity 0·4166, and 2 × 0·0694, being 0·5555. In burning it consumes twice its own volume of oxygen, and the 3 volumes become 1 of carbonic acid gas, and 2 volumes condensed into water, thereby producing heat, and the atomic energy of the conversion producing the radiation or protrusion of atoms called light.

Coal gas varies according to the coal and the perfection of the manufacture. Some made at Manchester, specific gravity 0·62 instead of ·5555, contained but 65 of carburetted hydrogen; the rest of the volume, of 100 parts, being 12 of alcoholic gas, 7 of carbonic oxide, and 16 of hydrogen.

The *second* is *alcoholic gas*, mis-named olefiant, constituting the most brilliant of lights, and made by heating one lb of alcohol in 4 lbs. of sulphuric acid. Its combustion is effected by 3 times its volume of oxygen forming 2 volumes of carbonic acid gas, and 2 volumes condensed into water. In proportions it is 2 of vapour of carbon, and 2 of hydrogen, and its specific gravity 0·9722, exactly the same as nitrogen and carbonic oxide.

There are other chemical compounds of carbon and hydrogen of no practical utility, such as an oil gas which consumes 4½ volumes of oxygen to 1 of the gas, and therefore very injurious to respiration, and some odd things called trito-bi-carbo-hydrogen, hexa-carbohydrogen, sesqui-chloride of carbo-hydrogen, &c. &c. !!

CARBONATE OF SODA; OR, MINERAL ALKALI.—Is the *mild mineral alkali* of former chemists, and the *sodæ subcarbonas* of the medical faculty, and is ordered by the College of Physicians to be made by dissolving Spanish barilla in four times its weight of water, filtering, evaporating to half its bulk, and setting it to crystallize.

Le Blanc and Dize's process is, to mix 180 pounds each of dry Glauber's salt, and chalk, with 110 of charcoal, to grind them together, to heat the powder in the side chamber of a reverberatory, stirring the mass every quarter of an hour. The mass becomes pasty; it is then drawn out by hoes into iron pots: the produce is about 300 pounds, containing about 100 of pure carbonate of soda. Six workmen can make nearly a ton and a half in 24 hours.

Carbonate of soda is also obtained, as a secondary product in the manufacturing of mineral yellow from lead.

Several attempts have been made to procure it from common salt, by calcining the salt with charcoal, but without success.

The best kind of carbonate of soda is called *barilla*, from a herb of the same name in Spain that produces it, the mesembryanthemum nodiflorum. The carbonate of soda, made of this plant, makes the best soap, the finest glass, and is the best for bleaching of any other. The two species of barilla contain 25 to 40 lbs. of carbonate of soda in 100.

In some manufactories wood vinegar is employed, to decompose Glauber's salt. It consists in boiling, for a given time, a solution of Glauber's salt, with a solution of acetate of lime, prepared with pyroligneous acid. In this operation the sulphuric acid leaves the soda to attach itself to the lime, and, at the same time, the acetic acid combines with the soda, and forms an acetate of soda.

The liquor is left to cool, filtered, evaporated to dryness, and the residuum calcined in a furnace; and when the acetate is entirely decomposed, nothing remains but a white substance, the solution of which, in water, evaporated to a suitable point, furnishes carbonate of soda.

Hodson took out letters-patent for the following process:—Having prepared 3 cwt. of well-burnt lime, it is slaked with a strong brine, and sprinkled with it until the salt appears to be accumulating on its surface. The lime thus slaked and saturated with salt, must be spread into thin layers, until the evaporation is completed, and then thrown into a reverberating furnace, with a chamber on the side. To this afterwards must be added, 3 cwt. of salt, or rock salt in a shelly state, and the whole melted with a strong heat. When this is effected, 2 cwt. of gypsum and 2 cwt. of sal enixum are to be introduced, and, by means of repeated stirring with a hoe, the different materials must be as generally, and as uniformly, distributed as possible.

Two spade-fulls of small coal, coke, or charcoal, must next be thrown into the furnace; and, by means of stirring as before, intimately united with the whole mass. This must be repeated, at intervals of the space of one quarter of an hour, until 2 cwt. of charcoal be consumed; if coal be used, until 3 cwt.; if small coal, until 4 cwt. be consumed.

The process must then be continued without any further admixture, with a strong heat, for three or four hours, or more, according to the degree of purity which it is designed the ash should possess. After which, the fluid mass is to be extracted by means of the hoe, and, when cold, broke up into lumps for use.

Dr. Thomson found, that, although carbonate of soda is sold in beautiful crystals, seven or eight inches long, all the specimens he could procure contained sulphate of soda, and generally in the proportion of two pounds in a cwt. He could not entirely separate this sulphate, even by twelve careful crystallizations.

*Sesqui-carbonate of soda*, is obtained by exposing carbonate of soda-water to an atmosphere, or current of carbonic acid gas, as in making bi-carbonate of potass. It may be considered as a combination of an atom of carbonate of soda with one of bi-carbonate of soda, or, as composed of two atoms of soda with three of carbonic acid, and four of water. It is the *sodæ carbonas* of the faculty, and is sold for making soda-water.

*Natrum, or Trona*, differs from kelp and barilla, as being principally formed of the sesqui-carbonate of soda.

*Bi-carbonate of soda*, is made by forcing carbonic acid gas into strong carbonate of soda-water: the crystals cannot be dried, for the least heat drives off a part of the carbonic acid, and converts them into sesqui-carbonate of soda.

*Carbonate of soda-water*, is used to discover the presence of lime in mineral waters, and acid solutions containing it.

*Caustic soda*, is *hydrate of soda*, and is prepared from carbonate of soda and quick-lime.

*Soda-water*, is prepared by dissolving carbonate of soda in water, two avoirdupois ounces to a wine gallon, and forcing carbonic acid gas into the solution by an apparatus.

Pure water, impregnated only with carbonic acid gas, is called *single soda-water*.

*Carbonic acid water*, or soda-water, is an acidulous drink, which is known as *water impregnated with fixed air*. In a brewery or distillery, a small quantity of carbonic acid water may be made, by holding a flat dish of newly-boiled water a little above the surface of the liquor fermenting in the working tun; and the water quickly absorbs its own measure of the carbonic acid gas that is discharged from the fermenting liquid.

Carbonic acid water is also made by putting pieces of marble or limestone into a retort, or gas bottle, adding very weak sulphuric acid, and receiving the carbonic acid in bottles, standing in the water-trough till they are half full; then shaking the bottles, to promote the absorption of the gas. *Or*, the water may be put into the receivers of Hastenfratz's distilling apparatus, or any similar apparatus; and the gas ejected from marble or limestone sent through it.

Welter's very ingenious apparatus is applicable to the making of carbonic acid water, and also to the preparation of the super-carbonates of the alkalies, and many other operations. It is a useful method for causing the absorption of gases, as it continues to act till the materials are exhausted, or saturated. When it is required to impregnate the water with a greater quantity of carbonic acid, an apparatus must be used, which will allow of considerable resistance being made to the escape of the gas; and, by this means, each measure of water may be made to absorb about two measures and a half of the carbonic acid gas.

Some persons use portable mechanical means, to force the carbonic acid gas into water, by means of a transferring pump, or syringe, which is connected at one end with the bladder, or other reservoir of the gas; and at the other with a vessel, or single bottle of water. When the pump is worked, the gas is extracted from the bladder, transferred, and forced into the water.

*Nitrate of soda*, is obtained by saturating the mother waters of the saltpetre workers with carbonate of soda instead of wood-ashes; or by saturating carbonate of soda with nitric acid, and then crystallizing.

*Muriate of soda*, is *common salt*, and called also *chloride of sodium, or murias natricus*, by Berzelius.

*Carbonate of ammonia*, the sal ammoniac, sal volatile, &c. of the shops. It is prepared by mixing one part of muriate of ammonia, with two of carbonate of lime, and subliming them in an earthen retort. Also, by distilling animal substances in iron pots, at a red heat. The first liquor is removed, and the salts sublime in crystals like bundles of needles, leaves, feathers, &c. When the salt is allowed to be dissolved in the water, it is called a spirit of the substance, as salt of hartshorn when made from horns; salt of soot, when from bones, &c. &c. As sold in smelling-bottles, its fetid smell is usually corrected by some odoriferous oil.

*Carbonate of magnesia*, the magnesia of the shops. It is prepared by precipitation, from sulphate of magnesia, by carbonate of potash. Equal parts, in their own weight of boiling water, are mixed hot, and filtered. Sulphate of potash is thus formed, which being separated by washing, the carbonate of magnesia remains to be stove-dried, as cakes or powder. It has been found native.

*Carbonate of lime*, is marble, chalk, lime-stone, stalactites, spar, &c. found by nature in great abundance, by the carbonic acid gas.

*Carbonate of potash*, known as vegetable alkali, fixed nitre, salt of tartar, salt of wormwood, &c. When pure, it is efflorescent, but, being mixed with potash for sale, it is deliquescent. It is prepared by incineration, or burning the vegetables, and lixiviation or washing, and then passing carbonic acid gas through the solution. Some distil the salt with carbonate of ammonia, which last ascends as gas.

CARBONIC ACID GAS, is the product of oxygen and carbon, and is produced by combustion, especially of charcoal, or by pouring sulphuric acid, diluted with five parts water, on chalk, which is itself carbonic acid and calcium. Carbonic acid forms one-third the weight of lime-stone, chalk, marble, spar, &c. and may be expelled by heat, or by some other acid, since it has weaker affinity for the earths than most other acids. Water absorbs it, especially if acted on by pressure, and thus becomes acid or brisk.

We are indebted to carbonic acid gas for the briskness of bottled beer, champagne, soda-water, Pyrmont water, &c. &c. No light will, however, continue in it, and, as the choke-damp, it is fatal to animal life, in wells, caverns, mines, &c. It is an intermediate substance between air and water. Hence it falls into low situations like water, and it may even be poured from one vessel to another. All fermentation generates it, and it lies on the top of all fermenting liquors, extinguishing lights, entangling animals, &c. It was well known to Paracelsus, Van Helmont, Boyle, and Hales, but Black ascertained how it might be made, and called it fixed air. Priestley discovered most of its properties. It is decomposed by plants, which absorb the carbon, and leave the pure oxygen. In union with potash, soda, magnesia, ammonia, it forms the important substances called carbonates, and sub-carbonates.

Carbonic acid gas is 44 parts in 100, by weight of limestone, marble, calcareous spar, &c. It has a weaker affinity for the earths than most other acids, and therefore is separated merely by pouring these on its combinations. Water absorbs more than its own bulk. Heated water parts with it, and also water in congelation. It consists, by weight, of 2 oxygen, (16) and 1 carbon (6) = 22. 100 cubic inches weigh 46·5 grains, of which 33·8 is oxygen, 12·7 carbon. Its specific gravity, in relation to air as 1, is 1·5236.

CARBONIC ACID GAS. *Choke damp*, or *fixed air*, is met with in the bottoms of mines left unworked, in old dried-up wells, in cellars, or in pits which have not been opened for some time, and in brewers' and distillers' working tuns, on the surface of the liquor. Its presence is shewn by its instantly suffocating men and animals that, deceived by its being invisible, venture into it; by instantly extinguishing the flame of a candle; and by the smoke of a newly-blown out candle floating upon it as oil on water.

When M. D'Arcet went to visit the very abundant and curious source of *carbonic acid*, existing at Montpensier, he endeavoured to ascertain personally the effect of the gas when respired. He kneeled down, therefore, near the larger source, supporting himself on his hands, and advanced his head slowly downward, intending to raise himself the moment he felt any indication of risk; but, on commencing the respiration of the gas, the effect of feebleness and extinction of power was so sudden, that he fell down flat, with his face entirely immersed in the current of carbonic acid, and would have lost his life but that the guide, whom he had forewarned, raised and carried him away to the fresh air.

The solar light, by favouring the assimilation of carbonic acid gas in plants, gives them the faculty of becoming green, and of forming the volatile and aromatic principles. These conditions are necessary to their flowering and fructification, insomuch that ripe seeds have never been obtained from plants kept in darkness. If, on the contrary, bleached plants are exposed to the sun for 3, 4, or 5 hours, they become as intensely green as if they had been reared in the sun. Vegetables reared in the open air become pale and fade in 2 or 3 hours, if they are transplanted to a dark place: but those which, after growing in the shade, have been exposed for some time to the sun, can no longer support the privation of light; and water, impregnated with camphor or essential oil, which is highly favourable to vegetation in other circumstances, does not prevent them from fading and perishing. The entire privation of light is, therefore, very hurtful to plants. The light of a lamp is capable of replacing that of the sun, though in a very imperfect manner. The plant becomes green, and directs itself towards the lamp.

CARDS, are made of 3, 4, or 5 thicknesses of paper, pasted, dried, and pressed. Playing-cards are made 3½ inches long, and 2½ broad, and made with blocks, in which the shape is open to receive the colour. The court-cards are produced by *stane-files* for the different parts and colours. What we call *hearts* were choir-men; *spades* were the nobles; diamonds were tradesmen, and clubs were trifles. The four kings were David, Alexander, Cæsar, and Charlemagne. The four queens were Argene, Esther, Judith, Pallas. The knaves were servants, or esquires.

They are marked from 1 to 10, with 3 court-cards, and in 4 suits; presenting, in their almost infinite variety, their various games, and the skill in playing them a source of endless amusement in hours not devoted to business, or exercise. Like every thing connected with chance, they are abused, by being made subservient to gambling for money; but, used for mere past-time, they afford the most innocent and agreeable of all recreations. All their varieties are governed by laws of chance, and no folly or weakness can be greater than the assumption that they are governed by any absurd luck, or ill-luck of parties, or by any preference for seats, &c. &c. In whist, for example, every 100 deals will average, for each hand, an equal number of every suit, and an equal number of repetitions of the same card to each hand. The result depends on the coolness and judgment of the player, whatever happens to be the power or weakness of his hand. They are made by stamps, with slight improvements since their first invention, about 1320, and all attempts to improve their design have failed.

In all polite companies, and civilized countries, they are a most agreeable recreation and pastime. They may be abused by indolent excess, or by being applied to gaming for money, so as to engender the worst passions. But the abuse must not be confounded with the use. In days of monkish darkness, and even in our days, where a puritanical spirit prevails, they are called the *Devil's Books*, but this is the same miserable superstition which directs fanatics to impose on themselves other self-punishments and mortifications. To play fashionable games with good temper, and in accordance with the laws of chance, is one of the marks of good-breeding and liberal education. *Hoyle*, or *Matthews*, are the most approved authorities.

*Enamelled cards*.—1 lb. of parchment cuttings, ¼ lb. of isinglass, and ¼ lb. of gum-arabic, are boiled in an iron pot, or other vessel, in 24 quarts of pure water, until the solution is reduced to 12 quarts, when it is to be strained clear. The solution is then divided into three equal portions, four quarts each. To the first is to be added 10 lbs. of pure white-lead, previously ground fine in water, and is Mixture No. 1. The second portion, with 8 lbs. of pure white-lead, forming Mixture No. 2; and the third, with 6 lbs. of pure white lead, is Mixture No. 3. Sheets of paper are then to be stretched out flat upon boards, and brushed over with a thin coat of No. 1. with a common painter's brush; the paper is then to be hung up to dry for 24 hours; after this, the paper is, in a similar manner, to receive a coat of No. 2, and dried again for 24 hours; the paper is then to undergo the same process with No. 3, and is dried for 24 hours more. It is now to be printed with the engraved plate, and the press-board to be of smooth cast-iron instead of wood. The printing being completed, the paper is to be hung up a fourth time for 24 hours to dry. After this, it undergoes the final operation of receiving its gloss, which consists in laying the work with its face downwards on a highly-polished steel plate, and then passing both, with great pressure, between a pair of cylindrical rollers. Thus the polished surface of the steel is transferred to the composition on the paper, which closely resembles the finest enamel.

CARDING, is wool, or flax combing, with a square piece of board, covered with leather, in which are fixed wire teeth. The making of them affords extensive employment, but the most perfect are those produced by Dyers' incomparable machine at Manchester.

CARD, is a board, or piece of leather, stuck full of wires, for combing, in level forms, handfuls of wool, or flax. It is effected now by machine power, and the cards are fixed on rollers, with which the material is brought into contact. They are made by children in workhouses, but better and cheaper by Dyer's patent machine at Manchester.

A self-acting machine was invented thirty years ago, for making wire cards for preparing wool and cotton; it bent, cut the wires, pricked holes in the leather, and inserted the bended teeth into these holes by one operation, without manual labour. The machine was very ingenious, and was made to operate with rapidity, and Mr. Dyer, a merchant, purchased the invention, and ultimately began the manufactory at Manchester, where he makes the best and most regular cards for every kind of work, with a facility that is surprizing to all who witness its performance.

CARDAMOMS, (Tincture of) is made by macerating, for 14 days, 3 ozs. of bruised cardamoms with a quart of proof spirit, then filtering.

CAREENING, is heaving a vessel down on one side, by applying a strong purchase to the masts, so that she may be cleansed from any filth which adheres by breaming.—A *half careen* takes place when it is not possible to come at the bottom of the ship; so that only half of it can be careened.

CARRAWAY, or CARUM, is a biennial plant, cultivated for its seed, and in particular at and near Glazenwood, in Essex. The seeds are perfected in the second year, and are much used by confectioners and druggists, as carminatives.

CARRAWAY SEEDS, are stomachic and carminative. The root is sweet, nourishing, and better flavoured than parsnips.

CARNIVOROUS, is applied to animals which eat up other animals, and they are distinguished by teeth calculated to tear flesh, and by their want of a cæcum in the intestines. Wallis and other anatomists insist that as the teeth of man are the same as those of gramminivorous animals, incisores and molares, and that man like them has a cæcum to detain the food, therefore man is not carnivorous, though generally so in practice, or when the flesh of dead animals is first cooked and disguised. It is certain that vegetable diet contributes to health and long life, also to strength, as we observe in the Irish, the Hindoos, and some hard-working African tribes, who live entirely on plain rice. The horse, the camel, and the elephant, too, are other examples of the energy resulting from vegetable diet. The ascetics, hermits, and dervises, so celebrated for great length of life, were all of them strict vegetable feeders.

CARROT, is a biennial plant, and although it contains much nutriment, it is difficult of digestion, particularly if eaten raw or imperfectly boiled. Carrots are an excellent fodder for cattle and horses, either alone or mixed with hay; and, if given to cows in winter, or the early part of spring, they are said to cause a great increase of milk, which will have a much less offensive taste and smell than when they are fed on turnips. Hogs thrive well upon carrots boiled with their wash. In some parts of England, this vegetable has been cultivated as a winter food for deer; and the tops have even been made into hay.

Carrots contain a large proportion of saccharine matter, and various but unsuccessful experiments have been made to extract sugar from them. They have been more advantageously employed in distillation. Ten pounds weight of carrots will yield about half a pint of very strong ardent spirit; and the carrots produced by an acre of ground, amounting to 20 tons, have been known to yield 240 gallons of spirit. A sirup made of these roots, and clarified with the whites of eggs, has been found useful for several purposes. An infusion of the seeds, and the expressed juice of the roots, are said to afford relief in fits of the gravel.

A marmalade of carrots has been used with success in sea-scurvy, and a poultice prepared from them is sometimes employed in cancerous ulcers.

M. Vauquelin has analyzed the juice of carrots. It contains albumen, mixed with a resinous fatty matter and mannite.

*To preserve carrots.*—Place them in a cask, with alternate layers of sand, and then close them tight, and place the cask in a dry cellar. The carrots are taken up for this purpose in August, and taken out for use in the following spring.

CARPENTRY, is the art of working and fitting wood to its various purposes of building and domestic economy. It is one of those trades in which dexterity is acquired by seven years' apprenticeship. It applies to all kinds of frame-work, to doors, windows, flooring, wainscotting, &c. &c. The chief tools are saws, planes, chissels, hammers, gimlets, augurs, centre-bits, compasses, axes, and adzes; with tools for mouldings, &c. &c. All these cost the journeyman from 15*l.* to 40*l.* and every one has his own chest of them. Every carpenter ought to be versed in practical geometry, arithmetic, and cross-multiplication; but by their square and rule most of them arrive, by short methods, at the results of science. The rolling of a marble, or the fixity of a drop of water, determines an horizontal line; the plumb-rule, a perpendicular. The sides 3 and 4 with a diagonal 5, a right angle; half of 5 for 45°, and a fifth for 20°. He knows, by experience, that every piece of timber or iron, in withstanding a compressing force, should be as many inches in thickness as it is feet in length. Also, that if a piece is equally loaded through its whole length, the flexure in the middle is but half, or 5 to 8, what it would be if the weight were collected in the middle.

In framing, where strength is the object, as in roofs, they are formed by a tie-beam, from wall to wall, from 50 to 80 or 90 feet, strengthened by trusses, or oblique pieces, with braces so combined, dove-tailed, and morticed, as to give the tie-beam the strength of a connected triangular plane, of which the rafters are two sides and the tie-beam the base. In a roof there are king-posts, queen or lesser posts, struts, straining-beams, purlins, pole-plates, &c. &c. whose varied purposes are the complete union of the rafters with the tie-beam.

CARPETS, are thick textures, composed wholly or partly of wool, and wrought by several very ingenious methods. The simplest mode is that used in weaving Venetian carpets, the texture of which is plain, composed of a striped woollen warp, on a thick woof of linen thread.

Kidderminster carpeting is composed of two woollen webs, which intersect each other in such a manner as to produce definite figures.

Brussels carpeting has a basis composed of a warp and woof of strong linen thread. But to every two threads of linen in the warp, there is added a parcel of about ten threads of woollen of different colours. The linen thread never appears on the upper surface, but parts of the woollen threads are, from time to time, drawn up in loops, so as to constitute ornamental figures, the proper colour being each time selected from the parcel to which it belongs. A sufficient number of these loops is raised to produce a uniform surface. To render them equal, each row passes over a wire, which is subsequently withdrawn. In some cases, the loops are cut through with the end of the wire, which is sharpened for the purpose, so as to cut off the thread as it passes out. In forming the figure, the weaver is guided by a pattern, which is drawn in squares upon a paper.

Turkey carpets appear to be fabricated upon the same general principles as the Brussels, except that the texture is all woollen, and the loops larger, and always cut.

In *Brussels* carpets, the worsted yarn, which forms the pile and figure, is not cut; in *Wilton*, the pile is cut, and hence its velvet appearance. In imperial Brussels, the pile is cut and the ground uncut; but in the royal Wilton, the pile is raised higher and cut. They are made of linen and worsted, the former binding the latter and not appearing in front, and the worsted warp only appearing.

In making carpets, the looms are similar to those in general use for weaving; but the worsted patterns require a curious, and often ingenious, disposition of the coloured yarns. This is effected by passing them from bobbins, with weights, through what are called harness, treddles, and the reed. The pattern is called a simple, and pricked on card, as the guide of the weaver. But no description can explain so complex an operation as that of combining five different colours in different lengths of the breadth. Sometimes barrels are marked, like those of an organ, but the French simple is generally used by means of treddles.

In Kidderminster carpets of two piles the warp and woof appear on the same side, and, of course, on the two sides the colours are reversed as the warp or the woof appears. When different colours are wanted, the warp is small yarn, but, in general, they have but two colours. Three ply carpets have lately been made, in which the woof shews the figure. In tapestry carpeting, the worsted warp shews the figure. In Venetian carpeting, a heavy worsted warp covers the woof.

England is the only country where carpets are in general use to cover the floors. In Persia, they are only in use to sit or sleep upon. In France, &c. they are very seldom used. In England, they are made at Kidderminster, Bromsgrove, Dewsbury, and Market-Harbro'; also at Wilton, Trowbridge, &c. and in some places in Scotland. Half a million of houses have 200 million of yards in constant wear; the consumption is, therefore, immense.

There is a very perfect carpet manufactory at Soestdyk, near Bruxelles, conducted by Cohen, which produces, in reported perfection, carpets of the fashion of all countries, from Turkey to the lowest Scotch articles.

CARTS.—Single-horse carts, in Scotland, draw 30 or 40 cwt. from 9 to 18 miles. They also dispatch harvest-work quicker than waggons. Two horses single are equal to three conjointly. Such carts are highly recommended by agricultural writers.

CARTOONS, were sketches in chalk, on thick paper, as patterns for tapestry or designs for painters. Those of Raphael are deservedly famous, and are preserved, at Hampton Court, as master-pieces of design. They are seven in number; Mr. Prince Hoare has one; and it is understood there were 25 by this great master.

CASCARILLA BARK, *(croton eleutheria,)* is the product of a tree of the Bahamas. It is warm, spicy, and bitter. When burnt the odour is that of musk. It is valuable as a tonic, like other barks, and also as a carminative, in cholic and diarrhœa. It is also used in the thrush. Its doses are from 12 grains to half a drachm.

CASE-HARDENING, is a process by which iron is superficially converted into steel, in such articles as require the toughness of the former, conjointly with the hardness of the latter substance. The articles intended for case-hardening are first manufactured in iron, and are then placed in an iron box, with vegetable or animal coals in powder, to undergo cementation. Immersion of the heated pieces into water hardens the surface, which is afterwards polished. Coarse files and gun-barrels are among the articles most commonly case-hardened.

CASE-SHOT, in artillery, is formed by putting a quantity of small iron balls into a cylindrical tin box, called a *canister*, that just fits the bore of the gun. In case of necessity, the canister is filled with broken pieces of iron, nails, stones, &c. The case is closed at both ends by wood. Shot of this sort are thrown from cannon and howitzers. A six-pounder shoots canister-balls of 1 oz. from 200 to 500 paces; 12 and 24-pounders shoot balls of 1 lb. 800 to 1000 paces. The number of the balls varies according to weight.

CASHEW-TREE, has a peduncle of the nut, which is astringent, and the juice is made into wine. The kernel of the nut is used to increase the memory, and quicken the genius. The shell of the nut contains acrid oil, and exudes gum.

CASHMERE GOAT, is a species of the common goat, descended from the goat of Thibet, which pastures on the Himalayas. In Thibet, this goat is a domestic animal. It is not allowed a very luxuriant pasture. The favourite food of these animals is buds, aromatic plants, rue, and heath. The people of Thibet give their goats, at least once a week, some salt, which has always proved a useful accompaniment to the customary food of these animals. If they are transferred from their cold, mountainous abode into a warmer country, the natural consequence follows, that the wool becomes inferior in quantity and fineness. The colder the region where the animal pastures, the heavier is its fleece. Proper food and careful tending increase the fineness of the wool. Yearlings afford the finest wool. A full-grown goat yields not more than eight ounces. The goats which pasture in the highest vales of Thibet have a bright ochre colour. In lower grounds, the colour becomes of a yellowish-white, and, still farther downwards, is entirely white. The highest mountains of the Himalaya, inhabitable by man, contain also a kind of goats with black wool, which, in India, and in the mountainous country of the goats, obtains the highest price, as a material for shawls. The goats of Thibet and Cashmere have the fine curled wool close to the skin, just as the under-hair of our common goat lies below the coarse upper-hair. The wool is shorn in the spring, shortly before the warm season—the time when the animal, in its natural state, seeks thorns and hedges, in order to free itself from the burden of its warm covering. All the hard and long hairs are picked out most carefully. The wool, thus purified, is washed, first in a warm solution of potash, and afterwards in cold water, in which process felting must be carefully avoided. It is then bleached upon the grass, and carded for spinning. The shawl-wool is three times dyed; before carding, after spinning, and in the shawl. The Asiatics avoid spinning the wool hard that the shawl may be soft. They use a spindle, which consists of a ball of clay, with an iron wire attached. The finger and the thumb of the spinner are kept smooth by steatite powder. A large shawl, of the finest quality, requires 5 lbs. of the wool; one of inferior quality, from 3 to 4 lbs. A machine has been invented in London, which spins this wool, in a very simple way, finer than can be done by the best spindles of Thibet, and, at the same time, of a firmer thread. In 1820, this species was introduced into France, and has succeeded very well. Joubert found that these goats were spread from Cashmere to the Ural, over Bucharia, in Independent Tartary, and he purchased them in the deserts, and transported them over the Volga to Theodosia, in the Crimea, where they were put on board vessels and carried to France. On the voyage, which lasted long, a great number died; but there remained more than 400 healthy animals, which were sent, from Toulon and Marseilles, to various parts of France.

Some time ago four Cashmere goats were imported into Essex, which, in 1830, had increased to twenty-seven. They thrive well, and feed principally on furze. Their hair is combed at intervals with an instrument like a curry-comb, and in the operation part of the hair comes off, which is used in the manufacture of shawls. Shawls from this raw material have been spun and woven, in England, superior in texture and beauty.

CASHMERE WOOL. Mr. C. S. Cochrane has patented "certain improvements in the preparing and spinning of Cashmere wool." The greater part of the Cashmere wool, which is manufactured into shawls to imitate the Indian shawl, is first brought to this country by our East India shipping, and sent to France, to be prepared and spun into yarn, ready for the weaver. This process of preparing is commenced by beating the wool with sticks, to loosen and remove a portion of the dirt incorporated with it as imported. The knotty portions are then to be separated by hand; for which purpose women and children are employed, till the moss assumes a uniformity of appearance, the long and coarse hairs being, at the same time, picked out; a process which is carried to a greater or less extent, according to the fineness of the fabric intended to be produced. The coarser portion is employed by the hat or felt manufacturers; and the finer portion is then to be submitted to hand-carding, using the cards with two rows of teeth, and about 32 teeth in each row. The patentee proposes to substitute, for these operations, a preparing machine, which consists of six rollers, or cylinders, about 10 or 12 inches in diameter, and 3 feet long: three of them furnished with a series of needle points, projecting from their surfaces, and the other three with hogs' bristles. The one set forms a series of cylindrical cards, and the other a series of cylindrical brushes; and they are fitted into a horizontal frame, with a card and brush cylinder placed alternately, so that the wool is first received from a feeding-board upon a card cylinder; thence it is transferred to a brush cylinder, then to a card cylinder again, and so on, till it is delivered upon a larger or doffer cylinder. When the wool is thus far prepared, whether by hand or machine, it is to be cleaned by repeated washings with soft soap and water, and subsequently subjected to the operations of carding machines and roving frames, which do not materially differ from some of the machinery used in this country for preparing wool for spinning.

In Cashmere, the weavers do not add above 1 inc. per day to their fine shawls.

CASHOO; a native of Bahar, the fruit of which is called cashoo-nut. The expressed juice makes a pleasant wine; and an aromatic and medicinal drug is prepared by a decoction and maceration of several parts of the tree, afterwards consolidated by evaporation. The Indians chew it. Europeans employ it as a digestive, and a soother of coughs.

CASH-REGISTER, is a very convenient machine to measure receipts at toll-gates, and where the turn of a gate is noted by the works. It requires the mere turning of a hand or index, and this operation registers the fact on another scale, enclosed in a locked case. The scale is divided into a small circle representing one pound, a larger one for twenty shillings, and a third circle on the edge of the card, every division of which stands for one penny, making together 240 pence. If the scale has more divisions than for a pound, the diameter of the circle should be proportionably increased.

*To clean Musty* CASKS.—Fresh cow-dung, distilled with water, in which four quarts of salt and one of common alum are dissolved, must be boiled together, and poured hot into the barrel, which must then be closely bunged, and well shaken. This operation must be performed several times, taking care to rinse the cask each time with clean water. Coopers cleanse them by taking out the head, and charring the inside with fire.

CASSAVA, MANIOC, or TAPIOCA.—Cassava has been cultivated in the stoves of Great Britain since 1739, having been introduced from South America, where it is most extensively grown, on account of its useful and medicinal properties. It is indigenous to Brazil, where there exist many varieties, differing in the breadth of the segments of their leaves. It blossoms in our collections in July and August. Two kinds are cultivated in the Colonies, the Sweet Cassava, (*Manihot aipi*,) whose root is of a white colour, and free from deleterious qualities: and the Bitter Cassava, whose root is yellowish, and abounds in a poisonous juice. It belongs to a tribe of plants, the *euphorbiaceæ*, distinguished by its acrid and poisonous qualities, and that the root of this plant abounds in juice of this character; it, nevertheless, yields abundant flour, rendered innocent by the art of man, and is most extensively employed in lieu of bread, throughout a large portion of South America; and is largely imported and served at table, under the name of Tapioca.

Such is the poisonous nature of the expressed juice, that it has been known to occasion death in a few minutes, and by means of it the Indians destroy many of their Spanish persecutors. M. Fernier, a physician at Surinam, administered a moderate dose to dogs and cats, who died in 25 minutes, the poison acting on the nervous system. 36 drops were administered to a criminal, and had scarcely reached the stomach, when the man writhed and screamed with agonies, and fell into convulsions, in which he expired in six minutes.

But, by various processes, by bruising between stones, with a coarse rasp, or by a mill, the root of the manioc is broken into small pieces, then put into a sack, and subjected to a heavy pressure, by which all the juice is expressed. What remains is cassava, or cassada, which, if properly dried, is capable of being preserved for a great length of time. In French Guiana, cassava-flour is made by toasting the grated root over the fire, in which state, if kept dry, it will continue good for nearly twenty years.

Cassava-cake, or cassava-root, is the *meal*, or the grated, expressed, and dried root of the manioc, pounded in a mortar, passed through a coarse sieve, and then baked on flat circular iron plates fixed in a stove. The particles of meal are united by the heat, and when thoroughly baked in this manner, they form cakes, which are sold at the markets, and universally esteemed as wholesome bread. The Spaniards, when they first discovered the West Indies, found it in general use among the native Indians, who called it *Cazabbi*, and by them it was preferred to every other kind of bread, on account of its easy digestion and the facility with which it was cultivated, and of its prodigious increase.

In Guiana, *cipipa* is another preparation from this plant, and is the name given to very fine and white fecula, which is derived from the expressed juice of the roots, and suffered to rest some time, when it deposits an amylaceous substance, which requires repeated washing, and is exactly analogous to our tapioca. The juice, evaporated, gives the tapioca meal. But it is from the roots of the sweet, or wholesome cassada, that our tapioca is made in Jamaica.—*Curtis's Bot. Mag.*

*Cassava, bitter, (Jatropha manihot.)* The root full of an acrid, poisonous, milky juice, separable by expression, or corrected by roasting, and thus yielding nutritive farina; by boiling the juice may be used as sauce, and made into soy. *Cassava, sweet, (Jatropha janipha.)* The roots soaked in water, dried and powdered, are nutritive. The *J. globosa* affords fruit which, in powder, is used to poison hyænas. The *elastic gum-tree, (J. elastica,)* yields, by incision, the elastic gum called *caoutchouc*.

*Cassava Bread* is made from the root of *Jatropha Manihot*, by expression of the juice, and baking the cake that is left. It is also made from *Yucca Gloriosa*.

*Tapioca* is prepared from the root of *Jatropha Manihot*, by washing the root, and thus preparing a fecule from it, which, when dried, is sprinkled with a little water and steamed, so as to form viscid irregular masses. These are dried in the sun until quite hard, and then broken into small grains. It is also made in the East Indies and Brazil.

*Potatoe Tapioca* may be made from potatoe starch, by boiling it before it is dried, and stirring it to break it into lumps.

CASSIA.—Wild cinnamon, or cassia, is the bark of a tree of the bay tribe, which grows in the East Indies and China, and is distinguished by having spear-shaped leaves, each with three nerves. This bark was well known to the ancients, and highly esteemed by them. But, since the use of cinnamon has been generally adopted, the cassia bark has fallen into disrepute, on account of its inferiority. It is thicker and more coarse than cinnamon, of weaker quality, and abounds more with a viscid mucilaginous matter. For many purposes, cassia, as being much less expensive, is substituted for cinnamon, but more particularly for the preparation of what is called oil of cinnamon; and nearly the whole of what is at present sold under the name either of simple or spirituous cinnamon waters, is prepared from cassia. The buds, as well as the bark, of this tree are used in cooking, &c. Cassia is chiefly imported from China.

CASSIA SENNA, is a plant of Ethiopia and Arabia, which yields the senna of pharmacy. The importation is 10 tons, and 7 are consumed in the United Kingdom.

CASTING.—Iron, as well as brass and other metals, which melt at temperatures above ignition, are cast in moulds made of sand. The kind of sand most employed is loam, which possesses a sufficient portion of argillaceous matter to render it moderately cohesive when damp. The mould is formed by burying in the sand a wooden pattern, having exactly the shape of the article to be cast. The sand is most commonly enclosed in flasks, which are square wooden frames, resembling boxes, open at top and bottom.

If the pattern be of such form that it can be lifted out of the sand without deranging the form of the mould, it is only necessary to make an impression of the pattern in one flask; and articles of this kind are sometimes cast in the open sand upon the floor of the foundery. But, when the shape is such that the pattern could not be extracted without breaking the mould, two flasks are necessary, having half the mould formed in each. The first flask is filled with sand, by ramming it close, and is smoothed off at the top.

The pattern is separated into halves, one-half being imbedded in this flask. A quantity of white sand, or burned sand, is sprinkled over the surface, to prevent the two flasks from cohering. The second flask is then placed upon the top of the first, having pins to guide it; the other half of the pattern is put in its place, and the flask is filled with sand, which, of course, receives the impression of the remaining half of the pattern on its under-side. After one or more holes are made in the top, to permit the metal to be poured in, and the steam and air to escape, the flasks are separated, and the pattern withdrawn. When the flasks are again united, a perfect cavity, or mould, is formed, into which the melted metal is poured. The arrangement of the mould is, of course, varied for different articles. When the form of the article is complex and difficult, as in some hollow vessels, crooked pipes, &c. the pattern is made in three or more pieces, which are put together to form the mould, and afterwards taken apart to extract them. In some other irregular articles, as andirons, one part is cast first, and afterwards inserted in the flask which is to form the other part. The metal for small articles is usually dipped up with iron ladles, coated with clay, and poured into the moulds. In large articles, such as cannon, the mould is formed in a pit, dug in the earth, near the furnace, and the melted metal is conveyed to it in a continued stream, through a channel communicating with the bottom of the furnace. Cannon-balls are sometimes cast in moulds made of iron, and, to prevent the melted metal from adhering, the inside of the mould is covered with powder of black-lead. Rollers for flattening iron are also cast in iron cases. This method is called *chill-casting*, and has for its object the hardening of the surface of the metal, by the sudden reduction of temperature, which takes place in consequence of the superior conducting power of the iron mould. These rollers are afterwards turned smooth in a powerful lathe, which has a slow motion, that the cutting tool may not become heated by the friction.

*Casting in Plaster.*—Copies are most frequently taken, both from new models, and from old statues, by casting them in plaster. For this purpose, a mould, in plaster, is first made from the surface of the statue or figure itself; and this mould is afterwards used to reproduce the figure by casting. Plaster is prepared for use by pulverizing common gypsum, and exposing it to the heat of a fire until its moisture is wholly expelled. The heat requisite for this purpose must be greater than that of boiling water. Care must be taken not to raise the heat too high, as, in that case, the sulphate of lime would be decomposed. While in the dry state, if it be mixed with water, to the consistence of cream or paste, it has the property of hardening in a few minutes, and takes a very sharp impression. The hardness afterwards increases by keeping, till it approaches the character of stone. Moulds are formed in the following manner: — The statue, or figure to be copied, is first oiled, to prevent it from cohering with the gypsum. A quantity of liquid plaster, sufficient for the mould, is then poured on, immediately after being mixed, and suffered to harden. If the subject be a bas-relief, or any figure which can be withdrawn without injury, the mould may be considered as finished, requiring only to be surrounded with an edging. But, if it be a statue, it cannot be withdrawn without breaking the mould; and, on this account, it becomes necessary to divide the mould into such a number of pieces as will separate perfectly from the original. These are taken off from the statue, and, when afterwards replaced, or put together without the statue, they constitute a perfect mould. This mould, its parts having been oiled, to prevent adhesion, is made to receive a quantity of plaster, by pouring it in at a small orifice. The mould is then turned in every direction, in order that the plaster may fill every part of the surface; and, when a sufficient quantity is poured in to produce the strength required in the cast, the remainder is often left hollow, for the sake of lightness, and economy of the material. When the cast is dry, it is extricated by separating the pieces of the mould, and finished by removing the seams and blemishes with the proper tools. Plaster casts are varnished by a mixture of soap and white wax in boiling water. A quarter of an ounce of soap is dissolved in a pint of water, and an equal quantity of wax afterwards incorporated. The cast is dipped in this liquid, and, after drying a week, is polished by rubbing with soft linen. The surface produced in this manner approaches to the polish of marble. When plaster casts are to be exposed to the weather, their durability is greatly increased by saturating them with linseed-oil, with which wax or rosin may be combined. When intended to resemble bronze, a soap is used, made of linseed-oil and soda, coloured by the sulphates of copper and iron. Walls and ceilings are rendered water-proof in the same way.

If the form or position require it, the limbs are cast separately, and afterwards cemented on. Moulds and busts are obtained in a similar manner from living faces, by covering them with new plaster, and removing it in pieces, as soon as it becomes hard. It is necessary that the skin of the face should be oiled; and, during the operation, the eyes are closed, and the person breathes through tubes inserted in the nostrils. Elastic moulds have been formed, by pouring upon the figure to be copied a strong solution of glue. This hardens upon cooling, and takes a fine impression. It is then cut into suitable pieces, and removed. The advantage of the elastic mould is, that it separates more easily from irregular surfaces, or those with uneven projections and undercuttings, from which a common mould could not be removed without violence.

CASTOR-OIL.—The castor-oil plant is a native both of the East and West Indies, and has a stem from 5 to 15 or 16 feet high. It is to the seeds of this plant that we are indebted for the drug called castor-oil. It is now often prepared by pressing the seeds in the same way as is practised with oil of almonds. The oil thus obtained is called *cold expressed*. But the mode chiefly adopted in the West Indies is first to strip the seeds of their husks or pods, and then to bruise them in mortars. Afterwards they are tied in linen bags, and boiled in water, until the oil which they contain rises to the surface. This is carefully skimmed off, strained, to free it from any accidental impurities, and bottled for use. The oil which is obtained by boiling is considered more mild than that procured by pressure, but it sooner becomes rancid. The mildest and finest Jamaica castor-oil is very limpid, nearly colourless, and has scarcely more smell or taste than good olive-oil. It is usually taken floating on peppermint or honey-water. It is imitated by 9 grs. of jalap, 3 of Venetian soap, and 1½ oz. of olive-oil, triturated in a mortar.

CASTS, are generally made in plaster of Paris, or calcined powdered gypsum, which, when wetted, makes a perfect impression, in a correct mould. In casting in metal, the mould should be clay and fine sand, or clay and finely-sifted coal-ashes. For medals, &c. melted sulphur is a more delicate material, or sulphur and red-lead make beautiful casts, in equal proportions, first cleaning and oiling the medal, &c. Thin tin-foil, worked into the medal with a point, and afterwards made a coat to plaster of Paris, poured into it, produces medals equal to silver. A coat of isinglass glue may be laid on a warmed medal, greased at the edges, with a camel-hair pencil, and, when dry, the glue may be picked off as a perfect cast. Carmine may be mixed with the glue or gold leaf, laid on the medal previously. Putty of calx of tin, and drying oil, also takes very perfect casts, and dries in a week. Of course, all good impressions may be used as casts for restoring the direction of the original.

The smoke of a candle on engravings, leaves, &c. is a good extemporaneous mode of taking accurate impressions.

*Glue Moulds for Casting.*—The body to be moulded, previously oiled, must be secured one inch above the surface of a board, and then surrounded by a wall of clay, about an inch distant from its sides; the clay must also extend rather higher than the contained body; into this warm melted glue, as thick as possible, is to be poured, so as to completely cover the body to be moulded; the glue is to remain till cold, when it will have set into an elastic mass. Having removed the clay, the glue is to be cut into as many pieces as may be necessary for its removal.

CATAPLASM OF MUSTARD, is equal quantities of mustard-seed and linseed, with hot vinegar. Cataplasm of yeast is flour 1 lb. and yeast ½ lb. set near to the fire to rise, and then applied to ulcers, gangrenes, &c.

CATARRH; OR COLD, is a disease of the skin, from chills, or closing of the pores, from which the perspiration escapes, and constantly balances the heat of the system. It occurs less in persons who, by daily washing and hard rubbing, keep their skin in healthy action, than in those who neglect such practices. The heat generated in the lungs is in consequence accumulated, some secretions increased thereby, and others diminished. Delicate organs, too, are affected, as the lungs, and morbid states of any organ are excited into disease. These effects must be counteracted by opening medicines, and diaphoretics must be resorted to; above all, pains should be taken to restore the perspiration generally, or partially, for if any part acts, the rest acts also, by a sort of sympathy. Flannel about the neck, clean flannels and linen, a warm bath to the legs and feet, and warm liquids in bed, are the best restoratives. Brisk exercise in doors, or violent without; so as to produce perspiration, by forcing the pores, is also useful. The editor of this work was much subject to colds, but having about 15 years since adopted the plan of daily washing all over in cold or tepid warm water, with free use of flesh-brush and rough towels, he has not in that time had a single cold, or if one, so slight as to escape his recollection.

CATECHU *(terra japonica)*; is an extract prepared from the wood and the green fruit of the *mimosa catechu* (Lin.) and of several other trees of the same family, which grow in the East Indies, principally in Bengal. There are three sorts of catechus. The first, *Bombay catechu*, is in square pieces, of a reddish brown colour, friable, of a uniform texture, fracture uneven, of a specific gravity of about 1·39. The second, *Bengal catechu*, is in round pieces, of the weight of three or four ounces, of a deep chocolate colour internally, and resembling iron rust externally, more friable, of the specific gravity of 1·28. The third kind, *catechu in masses*, is in irregular pieces of two or three ounces, of a reddish-brown colour, shining, homogeneous, and wrapped up in large-nerved leaves. These three kinds of catechu are inodorous, of an astringent taste at first, but, soon after, sweet and agreeable; at least, this is the case with the first and last sort. Catechu is one of the best astringents in the *materia medica*, and one the most in use.

Dr. Paris recommends a tooth-powder made of equal parts of catechu and Peruvian bark, and one-fourth of the powder of myrrh.—*See* ACACIA.

**CATGUT.** The strings of musical instruments, the cords of clock-weights, and those of some other machines and implements, are made of a dense, strong animal substance, denominated *catgut*. It is made from the intestines of different quadrupeds, particularly those of cattle and sheep. The manufacture is chiefly carried on in Italy and France. The texture from which it is made is that which anatomists call the *muscular coat*, which is carefully separated from the peritoneal and mucous membranes. After a tedious and troublesome process of steeping, scouring, fermenting, inflating, &c. the material is twisted, rubbed with horse-hair cords, fumigated with burning sulphur, to improve its colour, and dried. Cords of different size, and strength, and delicacy, are obtained from different domestic animals. The intestine is sometimes cut into uniform strips, with an instrument made for the purpose. To prevent offensive effluvia during the process, and to get rid of the oily matter, the French make use of an alkaline liquid, called *Eau de Javelle*. Catgut for stringed instruments, as violins and harps, is made principally in Rome and Naples. For the smallest violin-strings, 3 thicknesses are used; for the largest, 7; and, for the largest bass-viol strings, 120. In Naples, whence the best strings, commonly called *Roman*, are obtained, there are large manufactories.

*Catgut* is made from the intestines of sheep, by removing the mucous and peritoneal membranes, and soaking in lye; each gallon of water has an oz. of potash, and also another of pearl-ash, scraping the intestines with a copper-plate that has a semicircular notch, twisting them according to their uses, coloring them for whips, with ink, red ink, or sap green, and exposing them two or three times to the fumes of burning brimstone, used for tennis rackets, whips, hat-makers' bows, and clock-work. For fine catgut, used in musical instruments, the mucous and peritoneal membranes are carefully removed, the skins are soaked a day or two in water, with potash only, afterwards in water impregnated with burnt wine-lees, gradually made stronger, scraping off carefully the fat. As soon as they begin to float, they are taken out, twisted, brimstoned, again twisted, and dried. When sufficiently dried, the catgut is rubbed over with olive-oil, and kept, as long as convenient, as it improves by age.

*Catgut* is also made from the intestines of horses and asses. They are soaked in water, with a pailful of weakened *Javelle* bleaching liquid for each eight or ten sets; the mucous membrane is then separated, the intestine cut into four strips, by forcing along them a ball with four knives placed cross-wise; these strips are twisted, and, when dry, any slight inequalities are removed by fish-skin: used for turning-lathes and other machinery.

**CATHARTICS**, are a class of medicines which operate on the intestines, as laxatives, or drastic purges. The laxatives are manna, senna, sulphur, rhubarb, magnesia, Epsom salts, soda, brown bread, sea-water, &c. The purges are aloes, colocynth, Jalap, calomel, castor-oil.—*See* EMINA.

**CATHETERS**, *(Elastic Gum.)*—A bougie of fine catgut, thickly coated with wax, properly curved, is dipped in the ethereal solution of elastic gum until sufficiently thick; it is then dried, and boiled in water to melt the wax, and disengage the catgut.

**CATTLE**, a term applied to bulls, cows, and oxen, which are fattened at the rate of about 10 oz. of beef, per acre, per day each. There are about 5 millions in Great Britain, worth about 18*l*. each on the average. London consumes 160,000 per annum, worth 20*l*. each. The gross weight of each is from 700 lbs. to 900 lbs., and 200 to 250 lbs. is allowed for offal. Taking the increase per day at 8 oz. on an acre, or ½ lb., the produce is 187 lbs. per annum, which at 6*d*. is 4*l*. 13*s*. 6*d*. or at 5*d*. is 3*l*. 18*s*. 0*d*. to the farmer, besides the value of the offal, good management in cheaper means of fattening, with calves, milk, &c. But, against this, is to be set off the chances of mortality, disease, &c.

*Cattle, red water in.*—The best cure is a pound of common salt and 4 oz. of Epsom salts, dissolved in two pints of warm water. About half an hour after, give four pints of water-gruel, with half a pound of butter dissolved in it. The gruel must be continued every two hours, in the quantity of two pints. If the cow has not begun to mend at the end of 24 hours, the dose must be repeated as before. If this fail in opening the bowels, it may be aided by a glyster: boil an ounce of aniseed in a pint of water, dissolve 4 oz. of butter, and a table-spoonful of salt in it, after the seeds are drained out. For calves attacked by the red-water, give a strong calf 4 oz. of Epsom salts, with ½ an oz. of saltpetre, dissolved in about half a Scotch pint of water, followed by a pint of gruel, prepared as above.

*Cattle inflated by an excess of green food.*—The inflation which takes place in the stomachs of horses, cows, or sheep, in consequence of an excess of green food, may be frequently relieved by vinegar, which puts an end to the production of gas.

CAULKING, or CAUKING, of a ship, consists in driving a quantity of oakum, or old ropes, untwisted and drawn asunder into the seams of the planks, or into the intervals where the planks are joined together, in the ship's decks or sides, in order to prevent the entrance of water. After the oakum is driven very hard into these seams, it is covered with hot melted pitch or resin, to keep the water from rotting it. The Poles use a sort of unctuous clay for the same purpose, found on their navigable rivers.

CAUSTIC. The name of *caustic* is given to substances, which, by their chemical action, disorganize the parts of the body with which they are put in contact. They are sometimes called *potential cauteries*, to distinguish them from the fire called *actual cautery*, which latter, in general, act by decomposing chemically the tissues to which they are applied, by depriving them of life, and producing a real local and circumscribed gangrene, called *eschar*, or *slough*. Those, whose action is powerful, as caustic potassa, concentrated sulphuric acid, &c. produce these phenomena with such rapidity, that inflammation takes place only after the formation of the *eschar*; whilst, on the contrary, inflammation is the immediate consequence of the less energetic caustics. In both cases, suppuration occurs sooner or later, and separates the disorganized from the surrounding parts.

*Caustic Potash.*—If one part of carbonate of potash be dissolved in four parts of water, and the solution be boiled with slaked lime, the potash does not lose the smallest quantity of carbonic acid; it does not become caustic, even though lime be added to any extent, or however long the boiling may be continued. If, however, six parts of water be gradually added to the above mixture, it will be found, and without further boiling, that the potash loses its carbonic acid gradually; and that after the addition of the last portion of water, the potash is perfectly caustic. If the water be added at once, the potash becomes very quickly caustic. This peculiarity is explained by the fact, that concentrated caustic potash takes carbonic acid from lime. This fact is readily proved by boiling powdered chalk with concentrated potash, entirely free from carbonic acid; the solution added to muriatic acid occasions brisk effervescence. The carbonate of potash which is to be made caustic should be dissolved in at least 10 parts of water.—Taken internally, it acts in the same way as all corrosive poisons: it has, nevertheless, been administered, in very dilute solutions, as an antacid, diuretic, and lithontriptic. It has succeeded in the gravel, in nephritic colics, and other affections proceeding from superabundance of uric acid. It has been recommended, likewise, in the treatment of scrofula, and in some diseases of the skin, such as leprosy, &c.

*Caustic soda, (soda;)* protoxyde of sodium. Is similar to potassa, and it may be used with advantage as a *succedaneum*, when employed as a caustic.

*Caustic Kali, or Lapis Infernalis*, is a highly-concentrated alkali, in a white deliquescent substance. It is a protoxide of potassium, and so caustic as to be preferred, in surgical operations, to NITRATE OF SILVER,—which *see*.

CAVALIER, in fortification, is a work generally raised within the body of the place, 10 or 12 feet higher than the rest of the works. It is most commonly situated within the bastion, and made much in the same form. Sometimes the cavaliers are placed in the gorges, or on the middle of the curtain; they are then made in the form of a horse-shoe. Their use is to command all the adjacent works and surrounding country.

CAVE, or GROTTO; an opening produced by nature in any solid rock. Caves are principally met with in limestone of the transition and flœtz period, in gypsum, sometimes in sandstone, and in volcanic rocks; sometimes they are the effect of crystallization. The hollows in the earth may be divided into three classes: those of the first are wide clefts; those of the second admit the day-light at both ends, and form natural passages, which sometimes serve rivers as channels; the third and most common class consists of those which form a line of grottoes, about of an equal height, running in the same direction, and connected by passages more or less narrow.

There are many and various causes for the formation of caves. Those in limestone and gypsum are unquestionably results of the dissolving power of water; in fact, the almost perfectly uniform direction, the gentle and equable declivity of most caves, appear to be the effect of the long continuance of currents in them, the action of which has widened the existing crevices.

Caves of gypsum often contain foul air; and caves of limestone, various figures of stalactites, produced by the deposit of the lime dissolved in the water.

Most of the lime caves contain remnants of bones of animals, viz. of hyænas, elephants, bears. Many caves are remarkable only on account of their great size, or sublime, from the awful gloom which pervades them, and the echoes which roll like thunder through their vaulted passages. Some are of great depth, as that of Fredericshall, in Norway, which is calculated to be above 11,000ft. deep. One of the grandest natural caves known is Fingal's cave, in Staffa, one of the Western islands of Scotland. Its sides are formed of ranges of basaltic columns, which are almost as regular as hewn stone. The grotto of Antiparos, in the island of the same name, in the Archipelago, is celebrated for its magnificence. The passage at the entrance glitters in the torch-light, as if it were studded with diamonds. The roof is adorned with stalactites, many of them 20 feet long, and hung with festoons of various forms and brilliant appearance. In some parts, immense columns descend to the floor; others present the appearance of trees and brooks turned to marble. The Peak cavern, in Derbyshire, England, is also a celebrated curiosity of this kind. It is nearly half a mile in length, and, at its lowest part, 600 feet below the surface.

The caves of Kirkdale, in England, and Gailenreuth, in Germany, are remarkable for the quantities of bones of the elephant, rhinoceros, and hyæna, found in them. The mine of fluor spar, in Castleton, Derbyshire, passes through several stalactic caverns. Other caverns in England contain subterraneous cascades. In the rock of Gibraltar, there are a number of stalactic caverns, of which the principal is St. Michael's cave, 1000 feet above the sea. The most famous caves in Germany are those of Baumann and Bielstein.

The most celebrated caves in the United States are, Madison's cave, in Rockingham county, Virginia, extending 300 feet into the earth, and adorned with stalactites; Wier's cave, in the same county, extending 800 yards. Near Corydon, Indiana, is a cave, which has been explored for the distance of several miles, celebrated for producing Epsom salts. In Kentucky, and Tennessee, caves are numerous, which appear to have been used as burial-places.

Caves are sometimes found which exhale poisonous vapours. The most remarkable known is the Grotto del Cane, a small cave near Naples. In Iceland there are many caves, formed by the lava from its volcanoes. In the volcanic country near Rome, there are many natural cavities of great extent and coolness, which are sometimes resorted to as a refuge from the heat. The grottoes in the Cevennes mountains in France are both numerous and extensive, and abound in objects of curiosity. In South America is the cavern of Guacharo, which is said to extend for leagues.

CAVIARE, is made in Russia from the roe of sturgeons, belugas, and many other fish. The roe is separated from the skin which encloses it, salted, and, after eight days, pepper and finely-minced onions are added. It is then dried, and serves as a relisher with toasted bread, or bread and butter. The best caviare is from the Crimea.

CAYENNE PEPPER, or CAPSICUM, is the name of several species of South American plants, known by their hollow pods, of a shining red or yellow color, which contain many small, flat, and kidney-shaped seeds. The principal species are, heart or bell-pepper (*capsicum grossum*,) Guinea pepper (*capsicum annuum*) and bird-pepper (*capsicum baccatum*.) In hot climates, as in the East and West Indies, and some parts of South America, the fruit of these plants is much used for culinary purposes. It is eaten in large quantities, both with animal and vegetable food, and is mixed, in greater or less proportion, with almost all kinds of sauces. The Cayenne pepper used in cookery is made from the fruit of different species of capsicum. This fruit, when ripe, is gathered, dried in the sun, and then pounded; and the powder is mixed with a certain portion of salt, and kept for use in closely-stopped bottles. It is very generally used as a poignant ingredient in soups and highly-seasoned dishes. Its taste is extremely acrid, and it leaves a durable sensation of heat on the palate, which is best removed by butter or oil. When taken in small quantities, Cayenne is a grateful stimulant: and, in medicine, it is used both externally and internally, to promote the action of the bodily organs, when languid and torpid; and it is said to have been found efficacious in many gouty and paralytic cases. The Guinea pepper, or annual capsicum, is considered the most hardy; and, in the south of Europe, its fruit is eaten green by the peasants at their breakfasts, and is preferred by them to onions or garlic. The fruit of all the species may be used in domestic economy, either as a pickle, or when dried before a fire, and ground to powder in a common pepper-mill, as Cayenne pepper.

*To make Cayenne Pepper.* Grind 1 lb of capsicums and common salt, and colour with bole.—*Or*, 1 lb of English chilies and 4 oz. of salt, (very fine.)

CEDAR, a name given to several species of juniper, to a species of pine. It is an evergreen, and of great durability.

*Cedar-Larch*, or *Cedar of Libanon* (*pinus cedrus*, L.,) is distinguished, by its strong, remorse branches, from all other trees of the same genus. The general character of the shoot, even when the tree is young, is singularly bold and picturesque, and quite peculiar to the species. The tree is a native of the coldest part of the mountains of Libanus, Amanus, and Taurus; but it is not now to be found in great numbers. Maundrell, in his journey from Aleppo to Jerusalem, in 1696, could reckon only 16 large trees, though many small ones. The forest of Libanus seems never to have recovered from the havoc made by Solomon's *forty score thousand* hewers. In England there are probably, at present, more cedars than in all Palestine.

*White Cedar*, (*cupressus thuyoides*) is a small or middle-sized evergreen, naturally forming an elegant head. Its branches are not pendulous. Its leaves are of a delicate green colour. It is a native of North America, China, and Cochin-China. In the United States it occupies large tracts, denominated *cedar-swamps*. The wood is soft, smooth, of an aromatic smell, and internally of a red colour. It is permanent in shape, and very durable, and is esteemed as a material for fences. Large quantities of shingles are made of it. It is a favorite material for wooden wares, or the nicer kinds of coopers' work.

*Red or common Cedar*, (*juniperus Virginiana*;) a native of North America and the West Indies. The heart-wood of a bright-red, smooth, and moderately soft. This wood is in much request for the outsides of black-lead pencils. On account of its powerful fragrance, it is often used for the bottoms of drawers, because it resists the attacks of insects.

*Cedar, Berry-Bearing*, (*juniperus Phœnicea*.) Wood diaphoretic, and, by distillation, it yields huile de cade. Berries discutient; it exudes American olibanum.

*Jamaica Cedar* is the wood used for inclosing lead in pencils.

*Red Cedar*, or *Carolina Cedar*, is also used for inclosing pencils. Leaves used as savine. *Rosa Mala* yields liquid storax.

CELERY, is a garden product from the herb *smallage*, which is stronger in the smell and flavour than the cultivated species. The seeds are sown in the spring months in succession. It is eaten in soups, as salad, and as a stew.

Mr. Knight has found, that by keeping the ground in which celery is planted constantly wet, it grows by the middle of September to the height of 5 ft. and its quality is in proportion to its size. He also recommends planting at greater distances, and covering the beds, into which the young seedlings are first removed, with half-rotten dung, overspread to the depth of about 2 inc. with mould; under which circumstances, whenever the plants are removed, the dung will adhere, and it will not be necessary to deprive the plants of any part of their leaves. Good celery may be readily obtained by transplanting seedling plants that have remained in the seed-bed till they had acquired a considerable size.

*Celery root* is opening and diuretic, and useful in jaundice and the gravel. The seeds are more active.

CELLAR. A place to preserve wine and malt liquor, should be kept as nearly as possible, by opening and shutting air-holes, at a temperature of from 58° to 62°. Its entrance should be to the north, and it should have double doors. It should be 16 ft. deep and its roof 12 ft. high, and its floor be dry earth to the depth of 3 or 4 ft. It should be remote from all tremblings or concussions from the passage of carriages, or blows of hammers, and above all things be dry.

CELLULAR MEMBRANE, is the medium which connects and supports all the various parts and structures of the body. Any person may gain a general notion of this substance, by observing it in joints of veal, when it is inflated by the breath of the butchers. It consists of an assemblage of fibres and *laminæ* of animal matter, connected with each other so as to form innumerable cells or small cavities, from which its name of *cellular* is derived. It pervades every part of the animal structure. By joining together the minute fibrils of muscle, tendon, or nerve, it forms obvious and visible fibres. It collects these fibres into large *fasciculi*, and, by joining such *fascicula*, or bundles, to each other, it constitutes an entire muscle, tendon, or nerve. It joins together the individual muscles, and is collected in their intervals. It surrounds each vessel and nerve in the body, often connecting these parts together by a firm kind of capsule, and, in a looser form, joining them to the neighbouring muscles, &c. When condensed into a firm and compact structure, it constitutes the various membranes of the body, which, by long maceration in water, may be resolved into loose, cellular texture.

In the bones, it forms the basis or ground-work of their fabric, as receptacles in the interstices of which the phosphate of lime is deposited.

As cellular substance is entirely soluble in boiling water, it is considered, by chemists, as a peculiar modification of animal matter termed *gelatine*. In consequence of its solution by the united agencies of heat and moisture, the muscular fibres separate from each other, and form the other structures of the body. This effect is seen in meat which is subjected to long boiling or stewing for the table, or, indeed, in a joint which is merely over-boiled. It forms a connection and passage between all parts of the body, however remote in situation or dissimilar in structure; for the cells of this substance every where communicate, as we may collect from facts of the most common and familiar occurrence.

Its friction with rough towels or the flesh-brush contributes to health, and to the cure of many diseases.

CEMENTATION, is the exposure of a body to a high temperature with other bodies, so as to effect a change of chemical character. The substance with which the metal or other body is surrounded is called *cement-powder*.

In cementing *gold* the alloy is beaten into thin plates, and placed in alternate layers, with a cement containing nitrate of potass and sulphate of iron. The whole is then exposed to heat, until a great part of the alloying metals are removed by the action of the nitric acid liberated by the nitre.

*Iron* is cemented with charcoal powder and other substances, and thereby converted into Steel.

*Glass* is changed, by cementation with gypsum, into Réaumur's porcelain.

*Copper* is cemented with a powder of calamine and charcoal, and thereby converted into Brass. The copper obtained from the sulphate of copper, by precipitation with iron, is called *cement-copper*.

CEMENTS. Substances used for producing cohesion between different materials. They are mostly soft or semi-fluid, and harden in time.

The joints of iron pipes, and the flanges of steam-engines, are cemented with a mixture composed of sulphur and muriate of ammonia, together with a large quantity of iron chippings.

The putty of glaziers is a mixture of linseed-oil and powdered chalk.

Plaster of Paris, dried by heat, and mixed with water, or rosin and wax, is used for uniting pieces of marble.

A cement composed of brick-dust and rosin, or pitch, is employed by turners, and some other mechanics, to confine the material on which they are working.

Common paint, made of white-lead and oil, is used to cement china-ware.

So also are resinous substances, such as mastic and shell-lac, or isinglass dissolved in proof-spirit or water.

The paste of book-binders and paper-hangers is made by boiling flour.

Sealing-wax is composed of shell-lac and rosin, and is commonly colored with vermilion.

Wafers are made of flour, isinglass, yeast, and white of eggs, dried in thin layers upon tin plates, and cut by a circular instrument. They are colored by red-lead, &c.

Common glue is most usually employed for uniting wood, and similar porous substances. It does not answer for surfaces not porous, such as those of the metals, and is not durable if exposed to water.

Rice-glue is made by boiling ground-rice in soft water to the consistence of a thin jelly.

The cements mostly used in building are composed of lime and sand. Lime is procured by burning substances, in which it exists in combination with carbonic acid, such as limestone, marbles, chalk, and shells. By this process, the carbonic acid is driven off, and quick-lime is obtained. The quicklime is slacked by mixture with water, after which it swells and cracks, becomes hot, and assumes the form of a white and impalpable powder. This is a hydrate of lime, and contains about three parts of lime to one of water. When intended for mortar, it should be immediately mixed with sand, and used without delay, before it imbibes carbonic acid anew from the atmosphere. The lime adheres to and unites the particles of the sand. Fresh sand, wholly silicious and sharp, is the best. That taken from the sea-shore is unfit, as the salt is apt to deliquesce and weaken the mortar. From two to four parts of sand are used, according to the quality of the lime.

Water cements, called also *Roman cements*, harden under water, and consolidate almost immediately on being mixed. Certain rocks, which have an argillaceous as well as a silicious character, communicate to lime or mortar the property of hardening in a very few minutes under water. A peculiar earth, obtained at the town of Puteoli, *Puzzolana*, is evidently of volcanic origin. The Dutch, in their great aquatic structures, employ a substance denominated *tarras*, *terrass*, or *trass*, found near Andernach. It is a kind of decomposed basalt, and resembles *Puzzolona*.

Baked clay and common greenstone afford the basis of water cements, when mixed with lime, and some of the ores of manganese may be used for the same purpose. Some lime-stones, calcined and mixed with sand and water, also afford water cements, in consequence of containing argillaceous earth.

Some cements, of great hardness and permanency, have been obtained from mixtures, into which animal and vegetable substances enters, such as oil, milk, mucilage, &c. The name of *maltha* or *mastic* is given them.

In applying cements, the thinner the seam or the less of it the better, provided the joint adheres.

Jewellers use gum mastic to piece and unite stones, heating the stones.

*To resist moisture.* Mix shell-lac and alcohol with isinglass in alcohol.

*Another.* Glue 2, resin 1, melted with water, and any colouring earth added.

*Cheese Cement.* Skimmed-milk cheese sliced and boiled to glue; repeatedly washed, and then mixed with unslacked lime. When warm it unites broken earthen-ware, stone, &c.

*Botany Bay Cement, (for mending china.)* Mix equal quantities of yellow gum and brick-dust.

*Metal Cements.* Triturate 2 lbs. of iron-filings, 2 oz. of muriate of ammonia, 1 of sulphur, 1 part to 20 of filings with water; unites iron perfectly.

6 clay, 1 filings made into paste with linseed-oil; fits broken iron pots or cauldrons for use.

Clay, oxide of iron, and linseed-oil form another. *Or*, slacked lime and linseed-oil.

*Cutler's Cement.* 4 resin, 1 bees-wax, and 1 resin, fixes the handles of knives and forks.

16 rosin, 16 hot whiting, and 1 wax; *or*, pitch, resin, tallow, and brick-dust; *or*, 4 resin, 1 wax, 1 brick-dust, with tow, are the cements of work-shops.

Broken glass is cemented by interposing powdered glass, and heating the whole so that the powder may be melted first. *Or*, a cement may be made of powdered glass, fused with borax.

The juice of garlic is a good cement. Also quick-lime and the white of egg promptly used.

*Universal* or *Parolic Cement.* Curdle skim-milk, press out the whey, break the curd small, and dry well. Mix 10 oz. of dry curd with 1 oz. of powdered lime from the kiln-mouth, and 2 scr. of camphire, quickly put into wide-mouthed ounce phials, and carefully stop. Use a little with water, and apply quickly.

*Armenian Cement. (For porcelain, glass, and stones, to watch-cases.)* In alcohol dissolve isinglass till saturated, and to each ounce weight of this solution add 5 grains of gum galbanum, or gum ammoniac, and 6 tears of mastich saturated with alcohol. Keep in a stopped phial, which heat by water for use.

*To unite spar*, take 7 resin, 1 wax, melted and mixed with some plaster of Paris. Heat the spar.

*Stucco*, 100 parts of quick-lime are to be slacked by degrees, until reduced to the consistence of cream; 5 parts of white clay, previously diluted with water to a similar consistence, are then to be intimately mixed with the lime, and allowed to stand in a tub, or other vessels, for 24 hours, occasionally stirring it up.

*Parker's Cement*, is 6 pounded glass, 2 clay, 3 oxide of iron, 15 unburnt lime.

*French Cement*, is gum-water thickened with starch-powder. It keeps for a long time, and lemon-juice is sometimes added.

COHESION OF CEMENTS BY MR. BEVAN.

| | Per square inch. lbs. | mean. |
|---|---|---|
| Cement in bars, age 6 days, 1 dry, | 474 | 356 |
| 2 variable, | 360 | |
| 3 wet, | 234 | |
| ——— age 47 days, 1 dry, | 516 | 450 |
| 2 variable, | 564 | |
| 3 wet, | 270 | |
| ——— age 94 days, 1 dry, | 210 | 380 |
| 2 variable, | 618 | |
| 3 wet, | 312 | |
| ——— age 187 days, 1 dry, | 534 | 519 |
| 2 variable, | 708 | |
| 3 wet, | 336 | |
| Mean of the dry, | 433 | |
| ——— variable, | 562 | |
| ——— wet, | 288 | |
| With salt-water, | 924 | |
| With 51 per cent. of water, | 330 | |
| With 64 ditto, | 215 | |
| 3 parts cement, 2 parts sand, | 456 | |
| 1 part cement, 1 part brick-dust, | 312 | |
| *Bricks.*—3 parts cement, 2 parts sand, 6 months, | 375 | |
| 3 ——— 2 ? | 362 | |
| All cement, 9 months, | 360 | |
| Paving bricks, best sort, | 253 | |
| ——— seconds, | 194 | |
| Common building bricks, London, | 43 | |
| Common bricks, Soho, | 412 | |
| *Brick cylinders* laid in cement, | 27 | |
| ——— in cement and sand, | 68 | |
| ——— | 48 | |
| ——— | 53 | |

| | | | |
|---|---|---|---|
| *Brick piers* laid in cement 2 parts, rough lime 1 part, sand $1\frac{1}{2}$ part, | | 1 month, | $4\frac{1}{3}$ |
| *Brick piers* laid in puzzolano 3 parts, Dorking lime 1 part, | | 6 weeks, | 7 |
| ——— | pure cement, | | 21 |
| ——— | puzzolano 1, stone-lime 1, | | $8\frac{1}{4}$ |
| ——— | Atkinson's cement 1, sand 1, | | $25\frac{1}{4}$ |
| ——— | Ditto, | | $49\frac{1}{4}$ |
| ——— | cement 4, lime 1, | | 17 |

*Force required to* crush *per square inch.*

| | lbs. |
|---|---|
| A 14-inch brick pier, laid in first cement, | 470 |
| Puzzolano 3 parts, ground lime 1, | 296 |
| Atkinson's cement 1, sand 1, | 410 |
| Puzzolano 4, lime 1, | 638 |
| Ditto 3, Dorking lime 1, | 600 |
| Stone-lime 1, sand 3, | 500 |
| Portland-stone pier, | 2300 |

CENTAURUS BENEDICTUS, or the Blessed Thistle, was a plant of monkish efficacy, and varying in effects according to dose. A decoction is an emetic; an infusion acts on the skin, and 6 drachms of leaves infused in a pint of cold water is a stomachic.

CENTRE OF GRAVITY, is that point in a body from which its parts on every side equalize, and on which it might be suspended. It is readiest resolved by experiment or construction, for mathematicians have much perplexed the solution in complex cases. The force on every side must be equal. The best general rules are, to divide the distance between two bodies inversely as their weights, like a lever. Thus, if a body of 2 lbs. and another of 1 lb. are 3 ft. asunder, the centre of gravity will be 1 ft. from the heavest, and 2 from the lightest. The centre of a triangle is the spot where two lines meet, which are drawn from the centre of two of the sides to the opposite angles. Complex figures are determined by reducing them to triangles, and joining the centres of 3 in 1, till all are reduced to 1. For many bodies in a right line, the weights of each may be multiplied by its distance from any point, and the sum divided by all the weights, for a mean distance from the same point. When the bodies are not in the same plane, the perpendicular distance of each from a common plane may be multiplied by its weight, and the sum divided by the whole weights for a common distance.

When a body has been put in motion, one part of it is as worthy as another, or all its parts move alike; then this equality generates a centre of all the sides, called the centre of motion, and, in relation to bodies moving towards the centre, it is called the centre of gravity. In this respect it is the same whether the body is moving upwards, obliquely, horizontally, or downwards, the motion applies to all the connected atoms, and their own determination of their own centre is a necessary effect of the motion. Owing to our experience applying chiefly to bodies on a moving earth, which, owing to its general motions, determines its own centre, and causes all its parts to go towards the centre of its two motions, we usually discuss more at large the centre of falling bodies, and there are many problems for finding it, in difficult cases, in the works of Gregory, Hutton, and other mathematicians; but mechanical methods will best answer in the business of life.

It is often useful to determine the centre of gravity, since, if that is not supported, or is not within the base of the body, it will fall.

When the centre of gravity of a plain board is wanted, suspend it by any point, and a plumb-line from the same point will pass through the centre of gravity. Mark that line, and then suspend it by another point, and the plumb-line intersecting the first line will shew the centre of gravity.—*Gregory.*

*Or*, hang it by 2 strings from the same point at different parts, and a plumb-line hung from the same point will fall on the centre of gravity.—*Gregory.*

*Or*, balance the body in any manner in 2 different directions, and the point where the lines in both places cross is the centre of gravity. In all regular figures the centre of gravity is in the central line of the figure, and in complex figures the shortest way is to reduce them the whole to regular ones, and then find their common centre.

It should be observed, that although all heavy bodies are not actually in motion downward, yet they are nevertheless subject to the force, and by their weight are virtually moving, and they display this constant force the moment their centre of gravity ceases to be supported.

The force is such as would carry them

through 1 foot and the 32d of an inch in the first quarter of a second, accelerated as the *squares* of the time of falling; 4 ft. and the 8th of an inch in 2 quarters or half a second, and 16 ft. and an inch in four-fourths or a whole second, having then a velocity of 32 ft., so that in 10 seconds it falls through 1,608 ft. and 4 inc.; an effect which arises from the *surface* of the whole earth acting on the unsustained mass, and bringing it towards the centre, which centre is fixed by the forces of the two motions of the whole earth. A body, as a mountain, only remains beyond the usual circle of rotation because it is solid, and has a large base, for, as it tends to disturb or raise the centre towards itself, so the whole earth reacts against it, till it has brought it to the general spherical level. In a moving planet, just as in a moving billiard-ball, every part respects the centre, and all the forces act from it, and towards it, as a centre of gravity arising from the equal worthiness of every other part, and the consequent equilibrium around the centre. There is no virtue in the centre, but merely that of position in balancing the moved parts, and the tendency and force of fall is weight or gravity.

Centres of gravity, gyration, oscillation or percussion, have these relations. If P is a particle of any body B, and its distance is $d$ from the axis of motion S—then the centre of gravity is $\frac{P\,d}{B}$, of gyration $\sqrt{\frac{P\,d^2}{B}}$, and of oscillation or percussion $\frac{P\,d^2}{S.\,Gr.\,B}$.

Centre of Gyration. If the centre produced by any external force creating a revolution in bodies, and if the distance of the centre of oscillation from the point of suspension be multiplied by the distance of the centre of gravity from the same point, the square root of the product is the distance of the centre of gyration.

Centre of Percussion, is the point in which the force of a moving body is greatest. In a stick or rod moved from a centre, it is two-thirds of the length distant from the centre of motion. In a vibrating tri-angle or wheel the centre of percussion is three-fourths, and in a cone is four fifths of the length. This is called the centre of oscillation, in regard to weight or central force.

CENTERING, in bridge or arch building, is a frame of wood, or series of frames, connected by boards or planks, as the base of the curved masonry or brick-work. 1st. In center-framing, the strength must exceed the weight placed upon the convexity, in the form of the voussoirs, or arch-stones. 2nd. All openings or spaces between the timbers should be triangles. 3rd. All quadrilaterals should be avoided if possible. 4th. Equilibrium should be as much studied in the centre as in the stone-arch; for should a weakness discover itself on one side, and stability on the other, by the framing being unequally divided, a cripple in the arch itself will be the result.

In constructing the arches of London Bridge, there were nine of these framings to each arch, boarded over with very stout planking, placed within two or three inches of each other. The centre consisted of two parts. The first division embraced the greater portion of the curve at the place where the tie-beam passes through. The second was the part supported on piles driven into the bed of the river and fixed. The upper part might accordingly be gradually lowered by removing the wedges, thus preventing any sudden settlement.

Davy illustrates the advantage of coffer-dams over building by caissons. A caisson is an immense raft of timber, constructed of a form and size suitable to the pier; it is furnished with a bottom, ends, and sides, but the ends and sides may be drawn away: a portion of the pier proposed to be sunk to its proper place is erected in this sort of flat-bottom barge: and when all is in readiness, water is admitted in order to sink it, and it is guided in its descent by ropes, &c. The sides and ends are then withdrawn, and float to the surface, the lower planking remaining under the stones. The caissons at Westminster Bridge contained upwards of 150 load of fir timber of 40 cubic feet each, and were of more tonnage than a 40-gun vessel.

CERASIN, is the common name given to the gums which exude from the cherry, plumb, and astralagus.

CERATES, compounds of wax with fresh oils and unctuous substances, for the cure of wounds, on lint, when gold-beaters skin is inefficient.

*Simple Cerate.* Mix 4 oz. of olive-oil with a quarter of a lb. of melted wax.

*Calamine Cerate,* is 1 calamine to 5 simple cerate.

*Goulard's Cerate,* is 5 solution of acetate of lead or ceruse, half a ℔. of yellow wax, a drachm of camphor, and a pint of olive-oil. Mix the camphor with half the oil, and then add to the other.

*Rosin Cerate,* for foul ulcers, is made of 1 yellow wax, 2 white rosin, and 4 hog's-lard. Strain it.

*Savine or blistering Cerate,* is 1 bruised fresh savine leaves, 4 hog's-lard, and 1 yellow wax. Boil the first gradually, add the wax, and melt together. It is preferable to renewed cantharides, which often produce stranguary, erysipelas, and other effects of irritation.

CERIUM, Zirconum and Thorium, are chemical curiosities, but illustrate the principle of the compound character of all metals, and are made like aluminum.

CERUSE, or white lead, is an oxide of lead, and is prepared as an article of commerce, by the action of acetic acid on the metal. Plates of lead, being exposed to the vapours arising from boiling vinegar, are oxydized. To obtain it in large quantities, plates of lead, about 3 feet long, 6 inches broad, and 1 line thick, are rolled up in such a manner that a space of half an inch or an inch is left between each turn. These rolls are fixed, perpendicularly, in earthen vessels, which, at the bottom, contain strong vinegar. The latter, however, must not touch the plates; and, to prevent this, bars are placed over it, in the form of a cross. The vessels are then covered with plates of lead, and, being placed horizontally in tan or horse-dung, are exposed to a gentle heat. The vinegar, in vapours, settles on the surfaces of the lead plates, penetrates them, and dissolves a great portion of the metal. In from three to six weeks, the vapours of the acetic acid become saturated with lead, and change the latter into a whitish substance, which, after some time, is scraped off the plates. The plates are then rolled up again, and the process is repeated.

Ceruse is extensively used in the manufacture of oil paints, and, for this purpose, it is reduced to a fine powder. The pounding and bruising, however, are extremely injurious to health, for the dust, if swallowed, causes a dangerous disease, called the *painter's colic*. Mr. Ward invented a machine to guard against its pernicious effects.

CHAIN, is a measure of 100 links of 7·92 inches each, or 66 feet or 22 yards. 10 chains square are an acre.

CHAIN-PUMPS, consist of an endless chain, from 12 to 24 feet long, turned by a wheel with little vessels or pistons attached, and are useful in draining ponds and muddy places.

CHALDRON, an obsolete measure of 12 sacks, or 36 bushels.

CHALK, is carbonate of lime, in extensive strata, softened by admixture with argil and silex. It commonly contains 53 per cent. of lime. There are eight species, some of which are visibly remains of shells.

The compound powder of chalk is prepared chalk 4, cinnamon 2, gum $1\frac{1}{2}$, tormentil root $1\frac{1}{2}$, long pepper $\frac{1}{4}$. Pulverized. For severe diarrhœa, add one-fortieth of hard opium.

*To convert Chalk into Quick-lime.*—Expose it in an earthenware crucible, in a strong heat. Test it, by putting a piece into water, and adding muriatic acid, and if no effervescence, the conversion is perfect.

*Simple Chalk Mixture.*—Mix prepared chalk $\frac{1}{2}$ oz., loaf-sugar 3 drs., gum arabic $\frac{1}{4}$ oz., and water 1 lb.

*Prepared Chalk*, is made by triturating a lump with some water. Pouring this into a vessel of water, to settle partly, then pour off the upper water. The precipitate, when dry, is pure chalk.

Carbonate of lime may be prepared in the same way, but the operation on the first sediment must be repeated.

*Chalk*, when newly burned, grows hot with water, and falls into powder. It is antacid, and used in heart-burn. *Whiting* is made from soft chalk, by washing and forming into cakes.

*Italian White Chalk* is used for a crayon. *Blanc de Bougival* is white marle, composed of two parts clay and one of chalk. *Blanc de Rouen* is similar. *Blanc de Moudon* is silvery and silky, and used as whiting.

*French Chalk* is greenish, semitransparent, unctuous, and glossy, scrapes white, burns very hard and white; and is used to mark woollen cloth, and take out grease.

*Black Chalk*, or *Drawing Slate*, is fine black, compact, laminated, burns white or red.

CHALYBEATE WATERS, may be made by the gallon by dissolving 12 grs. of sulphate of iron with 4 drs. of bicarbonate potash, in a gallon of cold water, and shaking it well. Half a pint twice a day produces very invigorating effects, but the bowels should be previously purged.

CHAMBERLAIN'S RESTORATIVE PILLS, and Boerhaave's Red Pill, consist of cinnabar, sulphur, &c.—*Paris.*

CHAMOMILE, a perennial plant, flowering in June or July. Chamomile flowers contain an essential oil, of a fine blue colour, a gummo-resinous principle, camphor, and tannin. Water and alcohol dissolve their active principles. Chamomile is a moderately-energetic stimulant, possessing, on account of its bitterness, some tonic properties, which have rendered it popular. It is employed with success to stimulate the digestive functions. It is also used in slight intermittent fevers and spasmodic affections. A strong infusion, taken warm, and in a large quantity, provokes vomiting, and assists emetics.

CHAMPAGNE, is a wine which is made chiefly in the department of the Marne (*ci-devant* province of Champagne,) and is commonly divided into river and mountain wines; the former being, for the most part, white, the latter, red. All these wines are not sparkling or frothing, though by the name champagne is generally understood such wine as has been subjected to an imperfect fermentation, and contains a quantity of carbonic acid gas, generated during the insensible fermentation in the bottle. The briskest sorts are, of course, the most defective in true vinous quality; and the small portion of alcohol which they contain immediately escapes from the froth as it rises on the surface, carrying with it the aroma, and leaving the liquor that remains in the glass nearly vapid. Hence the still, or the creaming, or slightly sparkling Champagne wines, are more highly valued by connoisseurs, and fetch greater prices than the full-frothing wines. The vineyards on the banks of the Marne supply the choicest wines, and the quality degenerates in proportion as they recede from the river. Among the white wines of Champagne, the first rank is generally assigned to those of Sillery; but the Clos St. Thierry furnishes the finest red Champagne. The soil of the principal vineyards throughout Champagne is composed of a loose marl, resting on chalk, and sometimes mixed with flints. For the manufacture of the white Champagne wines, black grapes are now generally used. In making the red wines, the grapes are trodden before they are introduced into the vat. Champagne, when well made, and placed in cool cellars, will retain its good qualities from 10 to 20 years.—*Henderson.*

*Imitative* CHAMPAGNE.—The crystallized acids of the currant and gooseberry are used to acidulate well-fermented sugar, in imitation of Champagne. For this purpose, the best white raw sugar of the East Indies, in consequence of more readily and effectually running into a vinous state, is preferred. The wine thus produced certainly approaches nearer to the flavour, &c. of genuine Champagne, than the wine of the green gooseberry or of the white currant.

CHANK SHELLS, conchs, which, sawed in rings, are used as personal ornaments by women of Hindoostan.

CHARCOAL, is the carbonaceous part of wood, from which the volatile parts have been expelled by heat, while air is excluded so as to prevent oxydation. The tendency of effluvia, &c. to combine with this carbonaceous matter is such that it destroys bad odours and putridity of all kinds, and protects bodies from decomposition by arresting the active cause. Thus wood will not decay which is chared on the outside, and casks chared inside preserve water, beer, and wine. Placed in clothes' drawers, it absorbs their faint odour. Well powdered, it is efficacious tooth-powder. Boiled with putrid meat, or mixed with putrid water, it restores them.

Charcoal assumes two characters, as it is more or less burnt. Wood heated till black still burns with vapour and flame, and is a non-conductor of heat and electricity; but, if kept for some time at a red heat, it is less combustible and a good conductor of both. It absorbs bad odours, moisture, and gases, in such quantity, that, plunged in an atmosphere of ammoniacal gas, 90 times its own bulk disappears; in muriatic acid gas 85, in carbonic acid 35, in oxygen 9 or 10, in nitrogen $7\frac{1}{2}$, and in hydrogen nearly 2. Anthracite, plumbago, and diamond, are natural charcoals, or carbons.

It combines with oxygen in carbonic acid gas, in burning, and this is the basis of chalk, lime, and marble, of choke-damps, &c.; and so incombustible, that one volume of it in nine of air extinguishes a candle.

An equal volume of hydrogen with heat converts it into water and carbonic oxide. It is the constituent of all the carbonates or salts.

Carbonic oxide has but half the volume of oxygen, that is, in carbonic acid; and it burns with a blue flame.

The sp. gr. of carbonic acid is 1·5277, and of carbonic oxide ·9722, the very same as nitrogen.

Charcoal absorbs the oxygen from metallic oxides, and from sulphuric and phosphoric acids. It destroys putrescent smells, and purifies offensive water. It also abstracts the acid from vinegar, and brown and yellow colour from salts. It converts iron into steel, is a constituent of gunpowder, and the basis of black colours. In a word, in its various preparations it is of universal utility.

As a gas it forms three or four combinations, one of which, with oxygen, is carbonic acid, and another, with nitrogen, prussic acid. With the compound gas, chlorine, it forms other compounds, called chlorides. In fact, carbon is, with hydrogen, the primary element, if not itself, the first matter; and its low equivalent, 6, indicates its facility of combination.

Charcoal for common use is made by burning wood in a fire smothered with sods, &c.; but, medicinal charcoal is prepared in an iron cylinder, with a tube for the escape of effluvia, and heated red. Further purification is effected by heating its powder in a crucible till no flame rises from an orifice in the cover. It should then be kept close stopt, since it soon imbibes air, gas, and moisture very rapidly. It then corrects the odour of putrefaction, sweetens oil and mucilages, absorbs the colour of vinegar, and purifies fœtid water, de-oxydizes acids, and takes the colour out of spirits, &c. when filtered through it.

A new process, recommended in the *Journal des Forêts*, for this manufacture, is, to fill all the interstices in the heap of wood to be charred with powdered charcoal. The product obtained is equal, in every respect, to cylinder charcoal; and, independent of its quality, the quantity obtained is very much greater than that obtained by the ordinary method. The charcoal used to fill the interstices is that left on the earth after a previous burning.

Charcoal varies in its quality according to the nature of the substance from which it is prepared. The soft woods, as the willow or alder, is best for crayons, and for making gunpowder; the harder woods is used for fuel, or for a support for substances exposed to the flame of a blow-pipe. Charcoal of animal substances has the greatest clarifying power. Charcoal made by a low red heat, not exceeding cherry-red, has a dull surface, and is best for clarifying liquids, and probably for making gunpowder, or for fuel. If the heat is carried beyond this point, the charcoal acquires a brilliant surface, and is inferior for clarifying, and, probably for every other use. *Oak Charcoal*, *Beech Charcoal*, *Hazel Charcoal*, pile-burned, are those commonly sold for fuel. *Willow Charcoal*, pile-burned, is sometimes found mixed with common charcoal, and may be picked out for crayons, to polish copper-plates, for tooth-powder, and to put into poultices to correct fetid ulcers; also as an alterative in chronic costiveness.

*Charcoal obtained from wood.*—The following table contains the results obtained fron 100 parts of the shavings of woods, which had been carefully dried in the air. Two modes of carbonization were used; the one rapid and commencing with a high temperature, the other slow and gradual. The quantity of ashes was obtained by incineration of the charcoal under a muffle:—

| | RAPID. | | SLOW. | |
|---|---|---|---|---|
| | Charcoal. | Ashes. | Charcoal. | Ashes. |
| Young oak | 16·39 | 0·15 | 25·45 | 0·15 |
| Old oak | 15·80 | 0·11 | 25·61 | 0·11 |
| Young beech | 14·51 | 0·375 | 25·51 | 0·375 |
| Old beech | 13·75 | 0·4 | 25·75 | 0·4 |
| Young hornbeam | 12·81 | 0·32 | 24·91 | 0·32 |
| Old hornbeam | 13·31 | 0·35 | 26·11 | 0·35 |
| Young alder | 14·11 | 0·35 | 25·31 | 0·35 |
| Old alder | 14·91 | 0·41 | 25·25 | 0·41 |
| Young birch | 12·81 | 0·25 | 24·81 | 0·25 |
| Old birch | 11·91 | 0·31 | 24·41 | 0·31 |
| Young pine | 14·11 | 0·15 | 25·11 | 0·15 |
| Old pine | 13·91 | 0·15 | 24·85 | 0·15 |
| Young Norway pine | 16· | 0·225 | 27·51 | 0·225 |
| Old Norway pine | 15·11 | 0·25 | 24·51 | 0.25 |
| Young Scotch fir | 15·41 | 0·12 | 25·95 | 0·12 |
| Old fir | 13·16 | 0·15 | 25·81 | 0·15 |
| Lime | 12·91 | 0·41 | 24·21 | 0·41 |
| Rye straw | 13·11 | 0·31 | 24·31 | 0·31 |
| Fern | 14·25 | 2·75 | 25·21 | 2·75 |
| Reed | 12·95 | 1·71 | 24·75 | 1·71 |
| Old birch wood | 12·15 | | 25·11 | |

*Inflammation of powdered charcoal.* Col. Aubert states, that charcoal, when very finely powdered, has the appearance of an unctuous liquid, and occupies only one-third the space of sticks of charcoal of about six inches long. In this state of division, it absorbs air much more rapidly than when it is in sticks; still, however, the absorption goes on slowly, requiring several days for completion. It is accompanied with the disengagement of heat, which is to be regarded as the true cause of the spontaneous combustion of the charcoal; the heat being equal to about 350° of Fahrenheit. The inflammation occurs towards the centre of the mass, at about five or six inches beneath the surface. Black charcoal, strongly distilled, heats and inflames more readily than imperfect or slightly-distilled charcoal. But the black distilled charcoal, which is the most inflammable, ought to be in masses of about 60 lbs. at least, that spontaneous inflammation may take place; with less inflammable charcoal the inflammation occurs only in larger masses. In general, the inflammation occurs more certainly and readily, as the time is short between the carbonization and powdering. Air is not only necessary for the spontaneous inflammation, but there must be free access of it at the surface; the weight which the charcoal acquires to the moment of its combustion, is derived not merely from the privation of air, but partly to the absorption of water. Sulphur and nitre, added to the charcoal, take away its property of inflaming spontaneously; still, however, there is absorption of air and heating.

*Charcoal to light fires.*—When a fire is already kindled, in order to light another fire with charcoal, we have only to lay three or four pieces of it between the bars of the grate; and having then laid a few bits of fresh coal upon the bottom of the grate in which the second fire is to be made, lay the kindled pieces of charcoal upon them, taking care that the ignited parts be placed in juxtaposition. These may then be covered either with embers or with pieces of fresh pit-coal, and upon directing the blast of the common hand-bellows upon them, the heat of the charcoal will be immediately greatly excited, and instantly communicating fire to the fresh coal, the flame from that will farther aid the combustion of the charcoal, and a brisk fire be presently made. In case of there being no fire previously lighted, we must ignite the pieces of charcoal by directing the flame of a lamp or candle upon them.

Charcoal may be taken with rhubarb, in dyspepsia, and, with cinchona, is an excellent tooth-powder. It is also very useful as part of a bread poultice, for foul ulcers.

Box-wood charcoal is made by cutting it into short small pieces, and charing it in an earthen crucible, covered with dry sand, and heated till it ceases to flame. It should be kept in a stopper bottle.

*Alder Charcoal*, *Dog-wood Charcoal*, and *Spindle-wood Charcoal* are distilled in iron cylinders for making gunpowder.

*Chesnut Charcoal* is used by smiths for forging.

*Areca-nut Charcoal* is a dentifrice.

CHAY ROOT, produces the rich permanent red dye of the Hindoos, which, hitherto, has not been equalled in Europe, and has not been rivalled by our dyers, even with the use of this material.

CHEESE, the curd of milk, entire or skimmed, and, in Stilton and some others, of the cream itself, produced by rennet, or better by muriatic acid. It is used as a flavour to bread, but contains little nutriment, and is generally very indigestible. Nevertheless, the consumption is enormous, equal to half an ounce per day, or 12 lbs. per annum, to every individual in Great Britain, or 192 millions of lbs. per annum. Cows yield about 400 lbs. per annum; hence 500,000 cows are required for cheese. 22 millions of lbs. are imported, and 2 millions exported. The sorts are various.

*Cheshire*, made in that county, Flint, Denbigh, and Shropshires.

*Gloucestershire*, made in that county, Monmouth, Warwick, and Somersetshires.

*Derbyshire*, made in that county, Nottingham, and Leicestershires.

*Stilton*, made in Rutland, and N. E. of Leicestershire.

*Cream* cheese is sold new.

*Dutch* cheese, *Gruyere*, and *Parmesan*, are the sorts imported.

Cheese is the curd formed in milk, when coagulated by certain substances, and then pressed and dried for use. Cheese from new milk fresh from the cow is the best making, or one meal Gloucester cheese, of which two sorts are made, thin or single cheeses, about eight to the cwt., and thick or double, about four to the cwt. The single cheese is mostly made from April to November, the double only in May, June, and the beginning of July. In general, the milk in winter is not rich enough, and the cheeses made late in the summer do not acquire speedy firmness.

The liquid for coagulating milk is called rennet or runnet. A calf's stomach-bag, or maw, is washed clean, and salted thoroughly, inside and out. In two or three days, the salt left on it having run, it is hung to drain for two or three days, re-salted, put into a jar, and covered with paper, pricked with pin-holes. It may be used in a few days, but is best when kept for twelve months. When prepared for use, a handful of sweet-briar leaves, of dog-rose leaves, and of bramble leaves, as also three or four handsful of salt, are boiled in a gallon of water for a quarter of an hour, and when quite cold the salted maw is added.

Besides rennet, cheese may be separated from warm milk by many vegetable and mineral acids. Sugar and gum arabic is often used, and neutral salts and others effect the purpose, and are preferred in many countries.

In making cheese, the milk warm from the cow is first coloured, by rubbing down on a stone some annotto, about 1 oz. for each expected cwt. of cheese, and mixing it with the milk. The rennet is then added, about one-third of a pint to 50 gallons of milk. As soon as the milk is curdled, the whey is strained off, the curd broken small, put into a vat, and pressed gently for two hours, then turned, pressed again for six or eight hours, again turned, rubbed on both sides with salt, pressed again for twelve or fourteen hours, and finally dried on a board, being turned every day. In large cheeses, the sides are pierced with iron skewers to allow the whey to escape during the pressure, which is very moderate, upon a medium only $1\frac{1}{4}$ cwt. dead weight.

Colour is given with annotto-root,

turmeric, or marigold, but uncoloured cheeses are generally preferred.

Cheese is set for curd at 90° or 96°. If too cold, the curd is soft, and retains its whey. If too hot, it is hard and tough. $1\frac{1}{2}$ to 3 hours is allowed for coagulation, after mixing with the rennet. The curd is then worked by the hands and arms for three-quarters of an hour. When freed from the whey it is pierced for two or three hours. It is then put in the press, salted, and set to sweat. Sometimes yolks of eggs are mixed with the curd before pressing.

Cheshire cheese, famous all over Europe, is made from herds of from 100 to 400 cows, in rich pastures, sometimes 2 or 3 cwt. in a single cheese. The curd is hard if set too warm, and then requires breaking up by hand, and the green whey got rid of. The superiority depends on the milk and on experience in management.

Gloucestershire has hitherto been the principal seat of this manufacture, but North Wiltshire begins to take the lead. Chedder cheese is of this kind, and esteemed the choicest sort, but the quantity made is very small.

*Green cheese* is made by steeping over night, in milk, some sage, with half as much marygold leaves, and a little parsley, and then mixing the curd of this milk with the curd of white or ordinary milk.

*Cheshire cheese, made from the milk of two, or more milkings, mixed together.*—In general, only two meals, or milkings, are put together, but sometimes, when milk is scarce, 3, 4, or even 5 meals. The cold milk being creamed, $\frac{1}{3}$ or $\frac{1}{2}$ is made scalding hot, and $\frac{1}{2}$ is then added to the remainder of the cold milk, which has, in the meanwhile, been coloured by a piece of annotto, tied up in a linen rag, soaked all night in warm water, and then well rubbed into the milk, until the bag has given out all its colour. The other half of the scalded milk is mixed with the cream, and both the parcels added to the milk warm from the cow: this melting of the cream, as it is called, is thought to be the best method of uniting two, or more, meals of milk.

The Dunlop cheese of Scotland is also made from the evening meal of milk, warmed, mixed with the morning meal, and the rennet added immediately; no coloring is used. The whey as it gathers is laded off, the curd drained, and even pressed with a light weight. It is then cut up by a knife with three or four blades, salted, mixed by the hand, and pressed with a heavy stone, of 10 or 20 cwt. being frequently taken out and examined. When all the whey is pressed, the cheese is taken out, turned, and rubbed frequently with a coarse cloth. The usual size is from 20 to 60 lbs. in weight.

*Cheeses made by adding cream to new milk*, or *cream cheese.* Of this kind is Stilton cheese; the cream of the night's milk is added to the morning's milk, along with the rennet. The curd is not broken, but put into a sieve to drain, and very gently pressed; when the cheese is sufficiently firm, it is put into a wooden ring, and kept on a dry board.

A thicker sort of this cheese is called Cottenham cheese.

The Lincolnshire cream cheese, called in London new cheese, is made in the same manner. It is pressed with a two-pound weight, and sold when only a few days old. York cream cheese is thus made; the curd when turned out of the sieve is cut into a square cake, or tile, placed on rushes, covered with them, and pressed with a half-pound weight. It can only be kept in a cool place, and for a few days: the whey left in the curd becomes acescent, and this acidity is agreeable to some palates.

*Cheese made from new milk, mixed with skim milk.* The half covered milk Gloucester cheese is of this sort; they are usually marked with a heart, to distinguish them from the best covered milk cheeses, and are often called Warwickshire cheese.

*Cheese made of skimmed milk only.*—This cheese is only made in those districts where butter is the chief object of the dairyman; and the milk is used after it has been skimmed, as in Essex and Suffolk. The English cheese of this kind has seldom a good flavour; but although it is generally nearly as hard as horn, it is much easier of digestion than some of the soft cheeses.

The *Dutch* round cheeses which belong to this class are of a fine flavour.

*Parmesan cheese* is made of two meals of skimmed, the evening's meal having stood about 18 hours, and the morning's about 6 hours. The mixed milk is heated in a copper boiler to 82° Fahr. a lump of rennet, the size of a walnut, for 66 gallons, is tied up in a cloth, and worked through it into the warm milk, which is then turned from the fire, and left for an hour to coagulate; after which the curd is stirred up for another hour, broken much smaller by a stick stuck all round with wires, and left to settle. Part of the whey is taken out, the boiler turned again over the fire, $\frac{1}{4}$ of an oz. of saffron added to colour it, the milk made nearly to boil, keeping it well stirred, and occasionally examining some of the curd between the finger and thumb. When the curd feels sufficiently firm, the boiler is removed from the fire, three-fourths of the whey laded out, and three or four gallons of water dashed against the boiler to cool it.

A cloth is slid under the curd, and it is placed in a tub to drain; it is then put into a hoop and pressed with half a cwt. for an hour. The cloth is then taken away, the cheese placed again in the hoop for two days; after which the two cheeses are placed one on another, changing them every other day, for a month in summer, and six weeks in winter; during which period they are sprinkled over with salt, at each time of turning them. The cheeses are then scraped clean, turned every day, and rubbed frequently with linseed-oil, to keep off insects; they are never sold until six months old.

After the curd of Parmesan cheese is removed from the boiler, all the whey is added to the butter-milk of the morning's meal, which has been churned in the meanwhile, an acid added to coagulate it, and thus a cheese called maschopino is made.

The fatness of cheese cannot be ascertained by its appearance, but by toasting it, as some cheeses, apparently fat, dry up by heat, while other dry and hard cheese, when toasted, becomes fat.

A cow ought to produce her own weight and value in cheese by the year. 450 gallons of cow's milk ought to produce 430 lbs. of cheese.

*Cheese made from potatoes.*—Cheese, of fine quality, is manufactured from potatoes in Saxony. After having collected a quantity of potatoes of good quality, giving the preference to the large white kind, they are boiled in a caldron, and after becoming cool, they are peeled and reduced to a pulp, either by means of a grater or a mortar. To 5 lbs. of this pulp, which ought to be as equal as possible, is added a pound of sour milk, and the necessary quantity of salt. The whole is kneaded together, and the mixture covered up, and allowed to lie for three or four days, according to the season. At the end of this time it is kneaded anew, and the cheeses are placed in little baskets, where the superfluous moisture is allowed to escape. They are then allowed to dry in the shade, and placed in layers, in large pots or vessels, where they must remain for fifteen days. The older these cheeses are, the more their quality improves. Three kinds of them are made. The first, which is the most common, is made according to the proportions above indicated; the second, with four parts of potatoes, and two parts of curdled milk; the third, with two parts of potatoes, and four parts of cow or ewe milk. These cheeses have this advantage over every other kind, that they do not engender mites, and keep fresh for a great number of years, provided they are placed in a dry situation, and in well-closed vessels.

CHELTENHAM SALTS, are sulphate of soda, with minute quantities of soda, and common salt. Thomson's Cheltenham salts are the evaporation of a solution of sulphate of soda, and sub-carbonate of soda.

CHELTENHAM WATERS. The upper strata of water in the lias of Cheltenham, containing 27 parts of sea-salt, and $17\frac{1}{2}$ of sulphate of soda; whilst the water obtained by the deepest sinkings contains $72\frac{1}{2}$ parts of salt, and only $6\frac{3}{4}$ of the sulphate of soda; hence the true source of the sea-salt in these waters is the new red sandstone. The mineral waters occurring along the edge of the escarpment, where the lias are very thin and directly incumbent on the red marl, are almost pure brine springs, as Gloucester, Tewkesbury, &c. By the dip of the strata to S. E. these salt waters must necessarily be carried to considerable depths below the town of Cheltenham; and they are raised to their original levels by cracks and fissures, and then passing through certain soft and pyritous beds of the lias, obtain their peculiar medicinal properties.

CHEMISTRY, is the most useful and curious of all subjects of human pursuit, and though it has conferred much distinction within the last 60 years on many able men, yet the subtleties of nature are so numerous, that a rich harvest of renown remains for the next century.

The union of the elements in natural substances, and the protean forms of various proportions; the subtlety, too, of the atomic combinations, and their minuteness, though so complete, create endless mysteries. So much, however, has been determined, and so many new fields are opening, that, in a few years, it will be as perfect as delightful a science.

Who could have imagined, a few years ago, that oxygen and hydrogen at once form water, and light and heat; that the earths were metals and oxygen; that saltpetre was nitric acid and potash, results so unlike their originals. These discoveries, and a thousand others, arise from separations, by motions of the atoms in heat, or by the union of one of them at the moment of separation, with a third purposely presented, by which the desired body is set free and exhibited for examination and use. This is decomposition and analysis, and the principle has led to most of the discoveries in the science.

The details of the Arts of Life, in the main, are the details of chemistry.

Chemistry treats, 1. of the general powers of matter which have any influence on vegetation, of gravity, cohesion, chemical affinity, heat, light, electricity, the elements of matter, especially such as are found in vegetables, and the laws of their composition and arrangement; 2. of the organization of plants, their structure, the chemical composition of their organs, and the substances found in them, &c.; 3. of soils; 4. of the nature of manure.—Chemistry, finally, exerts an influence on the routine of domestic life, and on the arts. It simplifies and regulates the daily offices of the housekeeper; renders our dwellings healthy, warm, light; assists us in preparing clothing, food, drink, &c.: it teaches the best way of making bread; preparing and purifying oils; of constructing bake-houses, ovens, and hearths; of bleaching and washing all kinds of stuff; of producing artificial cold, &c. The application of chemistry to the arts and manufactures is, however, still more important and extensive.

*Chemical classification and nomenclature.* Combustibles combined with the simple supporters of combustion are sometimes called *binary compounds.* When their taste is acid, and they have the property of reddening vegetable blues, they are termed *acids.* If they are not acid to the taste, and have the property of turning blue what has been reddened by acids, they are distinguished by the termination *ide*, as *oxide*, *chloride*, &c.

If only one of the latter class is formed, that is, if the supporter of combustion will unite with the combustible in only one proportion, we call this compound, simply the *oxide*, *chloride*, &c. of the combustible; as, *oxide of carbon.*

If they unite in several proportions, we call the first, or that which contains the smallest proportion of oxygen, &c. *protoxide*, &c.; the second, *deutoxide;* the third, *tritoxide.* The highest is also called *peroxide.*

If only one acid is formed, we designate it by the name of the combustible, with the termination *ic.* Thus carbon with oxygen forms *carbonic* acid.

If several are formed, that which contains the larger proportion of the acidifying principle is designated by the termination *ic*, and that which contains less, by the termination *ous.* Thus sulphur forms *sulphuric* acid and *sulphurous* acid. If there are still intermediate compounds, we annex *hypo* (signifying *less*,) to designate a lower degree of acidity. Thus, we should have *sulphuric*, *hyposulphuric; sulphurous*, *hyposulphurous.* In the acids and oxides, chlorides, &c. the combustible is called the *base.* When the base is the same, the peroxide, &c. always contains less oxygen, &c. than the lowest acid.

For the names of compounds, those formed of acids and metallic oxides are called *salts*, and their individual names are formed, by changing the termination of the acid, and placing it before the name of the metal; the termination *ous* is changed into *ite*, and *ic* into *ate;* sulphurous acid with the oxide of tin would form *sulphite of tin;* sulphuric acid and tin, *sulphate of tin.* If the same acid combines with more than one oxide of the same metal, then we prefix the characteristic of the oxide to the name of the acid; thus sulphuric acid, combined with the protoxide of iron, forms the *protosulphate*, with the peroxide, the *persulphate*, of iron.

Other substances have also the property of uniting with acids, neutralizing them, and forming compounds analogous to salts. There are no general rules for the names of these compounds; but the substances themselves are called *salifiable bases.*

If the constituents are metals, they form *alloys.*

If the compounds are solid or liquid, and formed of a metallic, and a non-metallic combustible, we give to the latter the termination *uret;* as, carbon with iron forms *carburet of iron.*

If both are non-metallic, the termination *uret* may be attached to either; as, *phosphuret of sulphur*, or *sulphuret of phosphorus.*

If the compound is gaseous, we name the gas, or one of the gases, if it is composed of two, and join the other component as an adjective; as, *phosphureted hydrogen.*

*Chemical composition* is the result of perfect fitness of parts. The force, however, of mechanical cohesion, as well as the repulsive power of atomic motion, are in various degrees opposed, and the liquid, or gaseous forms, are most favourable to chemical union.

Again, the chemical union of bodies only takes place in *definite proportions*, or fixed mutual quantities of each body, which are invariable in the same compound, and it is commonly accompanied by a total change of their separate properties. Alterations of temperature almost always accompany the combination; and when the action is energetic, light and heat are displayed in abundance, and often with violence. Thus, if copper filings and sulphur be mechanically mixed together, they will exhibit no tendency to unite at the common temperature of the atmosphere; but, if heat be applied, as soon as the sulphur melts, a violent action takes place; the copper becomes red hot, and a black brittle body is produced, with properties totally different from copper or sulphur. This compound is often found ready formed in mineral veins; but whether the product of nature or of art, as above described, its composition is definite and invariable; and it is found to consist of 64 parts of copper and 16 parts of sulphur: or 100 parts contain 80 copper and 20 sulphur, or 4 to 1.

A second combination of copper and sulphur is of very common occurrence, and constitutes the ore from which nearly all the copper of commerce is derived. The proportions of this compound are 64 copper to 32 sulphur, or 2 to 1; that is to say, the copper is combined with exactly double the proportion of sulphur which exists in the first combination.

Mr. Baddely has rendered the public an acceptable service, by detailed descriptions of cheap apparatus for chemical experiments.

CHESNUT. The sweet chesnut is a stately tree, and few are more beautiful. The timber is frequently used for the beams and rafters of houses, and its appearance so nearly resembles that of the oak, that it requires the eye of a good judge to distinguish them.

For the heads and staves of casks, the wood of the chestnut is considered peculiarly excellent; and pipes made of it, for the conveyance of water under ground, are more durable than those made of either elm or oak.

For furniture, it may be stained so as somewhat to resemble mahogany. Hop-poles and poles for espaliers, and dead fences, made of young chestnut-trees, are preferred to most others.

Chestnuts, such as we import, are used, in warm climates, as flour, to mix for bread, in Corsica, &c.

Chestnuts, at the corners of every street in Florence, can be had in seven different forms: raw, cooked and hot, both roasted and boiled, dried by heat (the skins being taken off,) in which state they have a much sweeter and superior flavour, and made into bread, a sort of stiff pudding, and into thin cakes like pancakes.

*To keep chestnuts.* To preserve chestnuts, so as to have them to sow in spring, or eat through the winter, you must make them perfectly dry after they come out of their green husk. Then put them into a box or barrel, mixed with, or covered with, fine dry sand, 3 gallons of sand to 1 gallon of chestnuts. If there be maggots in any of the chestnuts, they will come out of the chestnuts, and work through the sand to get air.—*Cobbett.*

CHESS, is a game which, like geometry, teaches the art of reasoning, but unlike geometry it has no other uses except as pastime in sickness or bad weather. Its intricacy depends on the various powers of the 6 pieces brought into contest. Though but a game, it is one of skill, and therefore, as a mental exercise, greatly superior to any game.

CHESTS (MEDICINE,) *for Ships*, for a voyage, the physician of Greenwich Hospital judges necessary, for 100 men for 12 months, the navy chest thus fitted:—

1. *Pharmaceutic articles.* Peruvian bark, 10 lbs. [if for a warm climate 20 lbs.]—Glauber's or Epsom salt 10 lbs. [15 lbs.]—senna 2 lbs. [4 lbs.]—ipecacuanha 4 oz.—tartar emetic 1½ oz.—calomel 2½ oz.—opium 1 oz.—aloes ½ oz.—gum ammoniac 2 oz.—balsamic copaibæ 3 oz.—cantharides 1 oz.—capsicum 3 oz.—compound tincture of benzoin 4 oz.—camphire 3 oz.—castor 1½ oz.—camomile flow. or hops 2 lbs.—cinnamon 1 oz.—chalk, powdered, or oyster-shells 6 oz.—conserve of roses 8 oz.—Raleigh's cordial, 2 oz.—extract of cassia ½ oz. [3 oz.]—extract of hemlock 3 oz.—extract of logwood 1 oz.—gentian-root 5 oz.—ginger 3 oz.—gum Arabic 4 oz.—gum guaiacum 3 oz.—jalap 1½ oz. [2½ oz.]—laudanum (tinct. op.) 4 oz.—linseed 1 lb.—magnesia (subcarbonate) 6 oz.—manna 8 oz.—mustard-seed (whole) 8 oz.—myrrh 4 oz.—quicksilver 2 oz.—corrosive sublimate 1 oz.—nitrate of potass 8 oz.—almond-oil 1 pint—castor-oil 8 oz. [2 lbs.]—linseed-oil 3 pints—oil of mint 1 oz.—Jamaica pepper 4 oz.—quassia 8 oz.—volatile salts 2 oz. [1 lb.]—protosulphate of iron ½ oz.—subcarbonate of potass 10 oz.—Venice soap 8 oz.—sarsaparilla 3 lbs.—Virginia snake-root 4 oz.—spermaceti 4 oz.—spirit of wine 1 pint—spirit of vitriol 8 oz.—acetic acid, and ammonia 2 pints—oil of turpentine 4 oz. [4 lbs.]—dried quills ½ oz.—flowers of sulphur 1 oz. [1 lb.] golden sulphur of antimony ½ oz. cream of tartar 1 lb. [3 lbs.]—vinegar 6 pints—sulphate of zinc 1 oz.—wormwood 1 lb.—oxide of zinc 2 drachms.

2. *Surgical applications.* Simple cerate 6 lbs.—spermaceti ointment 6 lbs.—red oxide of mercury 1 lb.—sulphate of copper 8 oz.—blister plaster 6 lbs.—Garland's extract of lead 4 lbs.—acetate of lead 4 lbs.—cantharides in powder 1 lb.—strapping, lint, tow, rags, at discretion.

3. *Dietetic articles.* Barley 3 cwt.—eggs greased, and packed in salt 20 doz.—extract of spruce 12 lbs.—lemon-juice, clarified, and rum added to make it keep, 5 gall. [10 gall.]—raisins 50 lbs.—rice 2 cwt.—coarse sugar 2 cwt.—sago 20 lbs.—salep powder 10 lbs.—portable soup 50 lbs.—tamarinds 10 lbs.—white wine 300 gall.—red wine 100 gall.

4. *Necessaries.* 1 large clyster syringe, 1 small ditto, 6 for injections, 4 lancets, 1 tooth-instrument, 3 or 4 eye-cups, 1 doz. bougies, in sizes, 3 doz. phials with corks, 3 doz. pill-boxes, 1 set of scales and weights, lint and tow.

CHIARO-SCURO, (an Italian phrase, meaning *clear-obscure;* in French, *clair-*

*obscur*,) in painting, is the art of judiciously distributing the lights and shadows in a picture. A composition, however perfect in other respects, becomes a picture only by means of the *chiaro-scuro*, which gives faithfulness to the representation, and therefore is of the highest importance to the painter.

The drawing of a piece may be perfectly correct, the colouring may be brilliant and true, and yet the whole picture remain cold and hard. This we often find the case with the ancient painters before Raphael. The mode in which the light and shade are distributed on any single object, is easily shown by lines, supposed to be drawn from the source of the light which is shed over the figure; but *chiaro-scuro* comprehends, beside this, aërial perspective, and the proportional force of colours, by which objects are made to advance or recede from the eye. *Chiaro-scuro* requires great delicacy of conception, and skill of execution; and excellence in this branch of art is to be attained only by the study of nature and the best masters. *Chiaro-scuro* is also understood in another sense, paintings in *chiaro-scuro* being such as are painted in light and shade reflexes only, without any other color than that of the object, as in representations of sculpture.

CHILLIES, are pods which grow in Cayenne, and are the basis of the pepper so called. They also grow in Bengal, and are used as pickles.

CHIMNEY, the passage of smoke. Chimneys require much attention, to make them secure, and prevent their smoking. It is much better to exclude the cold damp air from the flues, by narrowing the aperture at the top, than to give a larger vent to the smoke, at the risk of admitting a quantity of air to rush down the flue. In Prussia, where the architectural police is strict, great attention is paid to the erection of chimneys, and to the regular sweeping of them, the chimney-sweepers being bound to sweep the chimneys of a certain number of streets within a regular time. The longer a chimney is, the more perfect is its draught, because the tendency of the smoke to move upwards is in proportion to the different weight of the column of air included in a chimney and an equal column of external air. Short chimneys are liable to smoke, and fire-places in upper stories are, therefore, more apt to smoke than those in the lower ones. Two flues in the same chimney should not communicate with each other.

Chimneys require, in their construction, skill and care in the bricklayer, not only with reference to their draught but the means of cleansing them. They ought to be plastered with smooth cement, so as to prevent the adhesion of soot, and have no ties but iron ties. If this were done, and enforced by law, machines would cleanse chimneys, and none of the dangers would arise which now take place when they take fire. In fact, in smooth chimneys soot would not lodge.

A very extensive series of experiments have been made on the velocity with which hot air ascends through tubes, the object being to ascertain the principal points which are necessary to be considered in the construction of chimneys. The conclusions are,

1. The tunnel or flues oppose a resistence to the motion of hot air through them, in the direct proportion of the length of the tunnel and the square of the velocity, and inversely as the diameter. 2. The co-efficiency of friction is not the same for different substances. 3. On contracting the upper orifice, the velocity of the air at the orifice increases to a certain limit, which is the velocity due to the pressure existing in the lower part of the tunnel. 4. On contracting the lower orifice, the quantity passed diminishes only in the proportion of the diameter of the orifice, and, consequently, the velocity in the orifice itself increases in the inverse ratio of its diameter.

A powerful draught is often indispensable, and is always useful in economizing the fuel. Up to this time, only two elements of draught have been considered,—the height of the chimney, and the temperature of the hot air; but the height is increased only at a serious expense, and to increase the temperature of the air requires the consumption of fuel. From the facts it appears that the diameter of the chimney is also an important element of draught; limited when the upper orifice is constant, but indefinite when that is free, and costing but little in construction. Thus, by augmenting the diameter of chimneys, and leaving the upper orifice free, or of a constant diameter, an increased draught may be obtained even when the temperature of the ascending column is diminished.

CHIMNEY-SWEEPING, by boys and children, is a frightful and disgraceful employment, which all men and women of feeling abhor and endeavour to suppress. In support of these correct and benevolent views, a Society has been established, and machines invented by sundry mechanics. Lately, the Society's machine was tried against boys in St. George's Hospital. Bentley, a master-sweep, his son, and three boys, were met by Glass and Day (the Society's agents) and two of their men; and it was agreed that the first chimney should be swept by Glass's machine, and that when this was finished, one of Bentley's boys should be sent up with his brush and scraper; then that the next chimney should be first swept by a boy, and afterwards by the machine, and so on alternately, till the 18 were completed. The result was most conclusive in favour of the machine; it being agreed, by all present, that the soot which was brought down by the boys, after the machine, was one-fifth less than the quantity brought down by the machine after the boys. The horrid practice of employing boys and children in this manner can only be stopt by law.

CHINA BLUE, is oxide of cobalt, melted with felspar and a little American potash. It is used to paint pottery ware, and as a general pigment.

CHING'S WORM LOZENGES, (yellow.) In mucilage of gum dragon, mix half a pint of water in which have been boiled two drams of saffron, and half a pound of calomel, with 14 lbs. of white sugar. *Or*, (brown.) In mucilage of gum dragon, mix 4½ lbs. of white sugar, 22 oz. of jalap, and 3½ oz. of calomel.

CHLORINE, or *oxy-muriatic gas*, that is, muriatic gas with an extra dose of oxygen, is made by pouring muriatic acid over powdered gray oxide of manganese. By this an extra dose of oxygen is imparted, and this has been called chlorine, though, in fact, it is nothing more than the *long-known oxy-muriatic acid*, which Scheele discovered in 1770. Of course, when potassium is heated in it, this gives out the hydrogen which renders it combustible, and by its combustion absorbs the oxygen of the oxymuriatic gas, or chlorine. The metal becomes a muriate of potassium, characterized by the saline origin of the gas, and the hydrogen remains. But this is no proof that the muriatic acid gas contained hydrogen, for this proceeds from the previously-combustible potassium, and is derived from the water in treating cream of tartar to make potassium. In a word, it is hydrogen which renders the alkali a combustible metal; and this hydrogen is given off when the acid of the oxymuriatic acid combines or displaces it.

Muriatic acid is of yellow colour, but the extra dose of oxygen converts it into green, and the same dose of the supporter renders it a supporter also.

It combines with other portions of oxygen as the odd numbers 1, 3, 5, 7, whose numbers are 44, 60, 76, and 92, as prot-oxide or euchlorine per-oxide, chloric acid, and per-chloric acid.

Chlorine was a name given by that original chemist, Davy, to oxymuriatic gas, and being shorter, and its compounds still shorter than the names of the compounds of oxymuriatic acid, it has been generally preferred. This powerful gas, under its first name and in some of its compounds, has been known to chemistry since 1783, for its bleaching and purifying powers: but as Davy could not decompose it, and it appeared in many processes to have greater power than simple oxygen, he maintained that it was an element, and sought to raise a mere product of the laboratory to an equal rank in nature with the universal formations hydrogen, nitrogen, oxygen, and carbon.

Common salt is a compound of muriatic acid and soda, called muriate of soda, which Davy called chloride of sodium. Now soda is sodium when soda is deprived of its oxygen, and sodium is soda when oxygen is imparted to it. In the first the oxygen is in the soda, in the last in the chloride. We therefore might write oxy-muriate of sodium as *exactly* equivalent to chloride of sodium, for they express the very same things. But as sodium is a mere laboratory product, so salt, with due respect to nature, is called muriate of soda.

To understand these points, observe the successive compositions.

*Muriatic acid* is made by distilling 32 ounces of dry salt, 20 ounces of sulphuric acid, and 20 ounces of water, till dry, and the product in the receiver is the muriatic acid. The acid and a third of the water are to be first mixed, and then added to the water in the retort. Its specific gravity is 1·6, and it is one-third gas, and two-thirds water. The dry residuum is super-sulphate of soda.

Then *Chlorine, or oxy-muriatic gas*, is made by distilling 100 salt, 30 oxide of manganese, 87 sulphuric acid, and 124 water; mix the acid and water cold, and then the salt and powdered manganese; and as the oxymuriatic or chlorine gas rises, pass it into 200 water, and it combines with it as *chlorine or oxy-muriatic water*.

Now, the slightest comparison shews, that the only difference in the two is the addition of the oxide of manganese in the last, to impart an extra dose of oxygen, which exactly accords with the muriate of soda (oxygen and sodium) or oxy-muriate of sodium, (soda without oxygen.) In fact, muriatic acid gas is 0·5 oxygen, 0·5 sulphur, and 2·5 hydrogen.

| | |
|---|---|
| Oxygen - - - | 16·944 |
| Sulphur - - - | 16·944 |
| 2·5 hydrogen - - | 5·295 |
| | 39·183 |

which is the exact weight of 100 oz. of muriatic acid gas, and this accords with all its sensible properties.

Oxymuriatic gas, or chlorine, is as under:—

| | | |
|---|---|---|
| 1 muriatic acid gas | - | 39·183 |
| 1 oxygen - - | - | 33·888 |
| $1\frac{1}{2}$ hydrogen - | - | 3·179 |
| | | 76·259 |

which is the exact weight of 100 cubic inches. Davy might not he able to analyse, but syntheses is as satisfactory as analysis. It is, of course, more powerful than single oxygen.

Chlorine, or oxymuriatic gas, is procured extemporaneously for purposes of fumigating empty apartments, by pouring 3 fluid drachms of sulphuric acid on 2 drachms of powdered oxide of manganese, and 4 drachms of dried salt. The mixture may be made in a cup or saucer, and put in a pot of hot ashes or sand. In an hour or two the doors and windows may be open.

Morveau's disenfecting bottles, containing the same ingredients, or the manganese, may be combined with muriatic and nitric acid, in equal proportions.

The chlorine, or oxy-muriatic water, forms *chlorides* with metals, and they combine with it more actively than with oxygen, because it contains a double dose of oxygen with sulphur, &c. and they are essentially alkaline.

There are chlorates of all the alkalis.

It also discharges all vegetable colors, and is an important article in bleaching, in which it resembles sulphurous acid.

The chlorine, or oxymuratic gas, may have other doses of oxygen imparted; the first, by mixing chlorate of potass with muriatic acid and water called *eu-chlorine*, or chlorous acid; the second, by heating over water, at 180°, a paste of hyper-oxymuriate of potash or barytes, and sulphuric acid called *chloric acid*. Per-chloric acid is also made of 7 oxygen to 1 chlorine.

When a burning taper is introduced into chlorine, it is quickly consumed with a dull red flame, which throws off a dense black smoke: phosphorus spontaneously ignites in it, and burns with a pale-white flame; and several of the metals, in a finely-divided state, or in thin leaves, inflame; and in this way tin, copper, and zinc, exhibit a beautiful appearance. Chlorine, mixed with the vapour of water, as it is usually obtained, assumes the liquid form at a temperature of 40°; and when surrounded with snow or pounded ice, concretes into a solid of a yellowish colour; which is deposited upon the sides of the receiver, like the effects of frost upon the surface of windows. If the gas be artificially dried by passing it over substances which abstract vapour, as a salt known by the name of muriate of lime, the most intense artificial cold produces no effect upon it. Strong compression, equal to four atmospheres, will, however, reduce it to the liquid form. It has no acid properties: it is not sour, and it does not change the blue colour of vegetables to red; but it destroys all animal and vegetable colours, and is a most important agent in the art of bleaching. This, however, it can only effect when water is present. If a piece of dry litmus paper be introduced into a jar of dry chlorine, it will suffer no change; but, if previously wetted, the colour will speedily disappear. The colours of printed calico may readily be discharged by the same means.

*Chlorine* and *hydrogen* may be mixed together; and, if carefully excluded from day-light, will remain without change. If the mixture be made with equal volumes of the two, and exposed to light, they will gradually combine; the chlorine will lose its peculiar colour and smell, and a powerfully acid gas will result, without any change of volume. If the mixture be made in a stout phial, with a well-fitted stopper, secured by wrapping a cloth round the neck, and exposed to the direct rays of the sun, the combination will take place suddenly and with detonation. When the stopper is afterwards withdrawn under mercury, it will be found that no condensation has taken place; but if under water, it will instantly rush in and fill the phial—as the new compound is rapidly absorbed by that liquid. The mixture may also be exploded by flame, or the electric spark.

It discharges all vegetable colours.

*Chlorine* and *nitrogen*. It may be obtained by passing chlorine through a solution of nitrate of ammonia, at a temperature of about 90°. The chlorine is rapidly absorbed, and an oily film appears on the surface of the solution, which collects into yellowish drops, and sinks to the bottom of the vessel. But this oily liquid is the most powerfully-explosive compound known, and should not be experimented upon in quantities larger than a grain of mustard-seed; and even then it should be handled with extreme caution. When a globule is thrown into olive-oil, or turpentine, it explodes so violently as to shatter any glass vessel.

Chlorine unites with the bases of all salts just like oxygen, and in like manner forms acids, at the same time the very principle which converts the base into an acid converts an alkaline base into an alkali. The chlorine acids unite only with chlorides, and the oxygen acids only with oxygen bases. The salts of muriatic acid, called muriates, are in fact chlorides, and there are 47 known varieties, as chloride of tin, gold, platina, &c.

*Chlorine, extemporaneous solution of.*

M. Tourtois gives the following quantities of ingredients for obtaining a solution of chlorine, which are to be added to an imperial quart of water, and well shaken together, in a stopped bottle :—

| | | |
|---|---|---|
| Sulphuric acid | - | 910 grains |
| Common salt | - | 280 |
| Deutoxide of lead | | 840 |

*To make chlorate of potash.*—Heat chloride of lime till it ceases to destroy vegetable colours. In this case a mixture of chloride of calcium and chlorate of potash is obtained. This is to be dissolved in hot water, and to the solution, concentrated by evaporation, chloride of potassium is to be added, and then suffered to cool. After cooling, a quantity of crystals of chlorate of potash is obtained, which are to be redissolved and crystallized again, to purify them. From 12 ozs. of chloride of lime, of so bad quality that it left 65 per cent. of insoluble matter, an ounce of chlorate of potash was obtained. The only difficulty to overcome in this process is, that the chloride of lime is not so easily decomposed by heat as is generally supposed; a solution of it may be kept boiling for an hour, without losing its bleaching power. The best method is, to form a thin paste with chloride of lime and water, and then to evaporate it to dryness : if it be required to prepare it, by passing chlorine into cream of lime, it is advantageous to keep it very hot. The chlorate of potash, which separates from the solution by crystallization, has not the form of scales, which it usually possesses, but is prismatic.

The *Annales des Mines* state, that the most effectual protection against the danger to be apprehended from the inspiration of oxy-muriatic gas chlorine, is to breathe the vapour of spirits of wine, or to swallow lumps of sugar steeped in alcohol.

CHOCOLATE, is a preparation of the cacao-nut, which is roasted, powdered, made into paste, and flavoured with sugar, vanilla, &c. It is then cast in moulds, and dried. It is highly nutricious, and the portable soup of travellers between the tropics. The French confectioners make delicious lozenges of it, and the consumption in France, Spain, and Italy is great.

*Chocolate (De Salaté.)* Roast 2 lbs. of island cacao with 8 lbs. of Caraccas cacao, and while hot add 10 lbs. of white sugar, and on a heated slab form into paste. *Or, (à la vanille.)* To 20 lbs. of the best chocolate-paste, add 1 scr. of cloves, and 3 oz. of cinnamon and of vanilla.

CHROMIUM, is a metal made from the ore, by digesting it with oxalic acid. Ammonia then precipitates a green substance, which, under intense heat, parts with its oxygen, and is reduced to the pure metal. The bichromate of potass is used as a yellow dye in calico printing. The chloro-chromic acid inflames with sulphur, turpentine, and alcohol.

The ore called chromate of iron being carefully picked, is stamped fine, and being mixed with half, or an equal weight of refined saltpetre, is put into skittle crucibles, so as to fill them about three-fourths of their height. The crucibles are then put into a furnace, gradually heated, and at last kept red-hot for half an hour. Being cooled, the crucibles are broken, the yellow spongy mass ground to powder, put along with the shards into a copper, along with 10 times its weight of water, and boiled for about half an hour. When cold, the liquor is filtered, and fresh water boiled upon the residuum, until it no longer acquires a yellow colour. The several parcels of water being mixed together are to be evaporated, to reduce them to a less compass, and saturated with nitric acid, to get rid of the silicate of potass and aluminate of potass which they contain. The water is then filtered, to separate the two earths, and potass is added until it again becomes yellow. By a careful evaporation and cooling, the nitrate of potass crystallizes, and scarcely any of the chromate of potass which is retained in the supernatant liquor. This mother-water being evaporated, deposits, upon cooling, very beautiful orange-red crystals of the acid, or bi-chromate of potass; and the supernatant liquor being again evaporated, yields a second crop of these crystals. The mother water is now very alkaline, and yields, on further evaporation, yellow crystals of neutral or sub-chromate of potass.

Chromate of potass is used for making chromate of lead; and also in calico-printing.

*Chrome yellow* is obtained by dissolving sugar of lead in a very large quantity of water, and pouring into it the rough solution of chromate of potass, from which the nitrate of potass has been just separated by crystallization, as long as any sediment falls. The liquor is then filtered, and the yellow left on the filters, dried for sale. Chrome yellow is used as a paint; and it is frequently sold for *peoree*, or *Indian yellow*, which is a gall-stone.

*Chrome scarlet.* Dulong's method is to boil 67 parts of white lead and 82 parts of chrome yellow, in a sufficient quantity of water. The carbonic acid of the white lead flies off, and the oxide of lead unites with the chrome yellow.

Grouvelle's method is, to boil 41 parts of chrome yellow, and 11 parts of sub-carbonate of potass, in a sufficient quantity of water; the carbonic acid flies off, as before, and the potass uniting with one half of the chromic acid, leaves the other half with a double portion of oxide of lead. It is a good oil-colour, possessing a good body, and mixing well with white lead. As a water-colour, it has stood for several months in exposed situations, and is equal in colour to red lead.

*Metallic chrome* may be obtained by reducing chloride of chromium with ammoniacal gas in the same way; the metal is not then black, but of a chocolate-brown colour.

When a neutral solution of oxide of chrome in muriatic acid is evaporated, there is obtained a green mass, which does not alter at the temperature of boiling water, and even at some degrees above it; but when the temperature is very considerably raised, it begins to swell, and losing water is converted into a spongy crystalline brilliant mass of a peach-blossom colour. When the chloride of chrome is calcined in contact with the air, it is converted into a fine green oxide.

If sulphuretted hydrogen gas be passed over chloride of chrome, a brilliant black crystalline sulphuret of chrome is obtained.

Metallic chrome does not alter at a red heat; nor does it by continued calcination become green. If chloride of chrome be fused, in proper proportion, with muriate of ammonia and carbonate of soda, metallic chrome is not obtained, but prot-oxide of chrome, in crystalline scales, and green transparent crystals of common salt, which have a fine green colour, and apparently combined with chloride of chrome.—*Ann. de Chim.*

When dry ammoniacal gas is passed over the tripple compound of chloride of chrome and ammonia, heated to redness in a glass tube, it is completely decomposed, and black pulverulent metallic chrome is obtained, which acquires a metallic lustre when burnished, burns when heated to redness, and gradually going out becomes a brown powder.

*Chromate of iron* is found in masses in the Shetland Isles, and in mines. It is black, and hard enough to cut glass, &c. &c.

*Chrome yellow*, or *Chromate of lead*, is prepared from chromate of iron, by heating it with nitre or pearl-ash: then wash the mass, and mix the ley with a solution of lead in nitric acid, or sugar of lead in water, when it will not effervesce with nitric acid. It is used as a gold-colour paint.

CHRONOLOGY. Whatever opinions may be formed of the true antiquity of the world, from the examination of the strata, and the evidence of the fossil remains, it is useful, in consulting books of history, to be acquainted with estimates of past time. The date of the year indicates the period since the epoch fixed for the birth of Christ, but the period from Christ to Adam is variously estimated as under:—

| | |
|---|---|
| Alphonso X. - - | 6984 |
| Suidas - - - | 6000 |
| Septuagint Version - | 5634 |
| St. Clement - - | 5624 |
| Other Septuagint - | 5508 |
| Eusebius - - - | 5200 |
| Josephus - - | 4698 |
| The Vulgate - - | 4184 |
| Usher - - - | 4004 |
| St. Jerome - - | 3941 |
| Modern Jews - - | 3760 |

Then 1833 added to the first gives 8817 for the time since Adam, and to the last 5593.

Since the perihelion past the equator is about $\frac{100}{360}$ths. of 20931 years, or 5814 years, which would be an epoch of flood in all the tropical regions, and last for a few hundred years. This, therefore, must be the Jewish epoch, and not that of Adam, which would then accord with the authoritative researches of Alphonso, and the Spanish and Arabian Universities.

The flood of Genesis is unsettled by these discordances, but by the perihelion forces it took place about 4000 B. C.

| | |
|---|---|
| The Era of Rome was | 753 B. C. |
| First Olympiad | 776 |
| Seleucidæ - | 311 |
| Alexander - | 328 |
| Julian Era - | 45 |
| Spain - | 38 |
| Actium - | 30 |
| Jewish Era - | 3761 |
| Chinese Cycle | 2277 |
| Kali-Yug - | 3101 |
| *After Christ.* | |
| Diocletian - | 284 |
| Mahomedan Hygira | 622 |

The call of Abraham was in 1941; the Jews left Egypt, 1491; Jupiter reigned in Crete, in 1450; Troy was taken, 1184; David reigned, 1050; Captivity of the 10 tribes, 721; Nebuchadnezzar destroyed Jerusalem, 598; Death of Cyrus, 529; Death of Alexander, 323; Carthage destroyed, 144; Death of Pompey, 48; Birth of Christ, 4; and Crucifixion, 33.

Such are the standards of chronological computation, and if we cannot ascend higher, it is because there could be no records till the invention of letters, about 1700 or 1800 B. C. or after the age of Abraham.

CHURNING, is the continued agitation of cream, so as to separate the unctuous from the serous part. The unctuous atoms, being less moved, aggregate and clot, till entirely separated. Latterly, barrel churns, as more convenient in action, have been introduced.

Warmth is necessary for the purpose of keeping the unctuous parts oily, so as to accelerate their separation from the whey or serum. The butter produced is solid oil, and it melts at 96°.

CHRYSALIS, or AURELIA. A state of rest, and seeming insensibility, which butterflies, moths, and other insects, pass through from the grub state before they arrive at their winged state. The figure of the chrysalis generally approaches that of a cone; or, at least, the hinder part of it is in this shape, and the creature, while in this state, seems to have neither legs nor wings; no power of walking, and takes no nourishment. Its posterior part is all that seems animated. The external covering of the chrysalis is usually smooth and glossy; a few have hairs; and others are rough or shagreened.

CHYLE, the milk-like liquor which is observed, some hours after eating, in the lacteal vessels of the mysentery, and in the thoracic duct, and which has been separated by digestion from the chyme. Its chief use is to supply the matter from which the blood and other fluids are prepared; from which again the solid parts are formed. Hence the importance of proper food and drink, for the production of this important fluid in the animal economy. The milk secreted by females is chyle, for the nutriment of their young.

CHYME, is the ingested mass of food, forming a pap-like substance, and after continuing some time in the stomach, it passes into the duodenum; where the chyle is prepared by the mixture of bile, &c.

CIDER, the juice of apples, allowed to ferment, so as to become a vinous liquor; much drank in the western counties of England.

To make good cider, it is essential that the fruit should be of the proper kind, and also that it should be perfectly ripe. The apples which ripen before the middle of September, do not often make good cider. Those which ripen after that period will be found generally to make good cider. To know when the apples on a tree are ripe, it is only necessary to shake it moderately, and if the apples fall in profusion, we may be assured that they have obtained all the sustenance from the tree which they are capable of receiving, and the whole may be shaken down, although it is a more common practice to let them fall gradually off the trees, and to pick them up every day. Some kind of apples, notwithstanding they fall off the tree, require to be kept for some time, to acquire the mellow ripeness necessary for making the best cider; and *all kinds of apples* should be kept as long as they can in general be, without decaying.

Many who make the best cider, do not separate the different kinds, but mix them altogether, while others scrupulously keep them apart.

The weight of the cider immediately after it is expressed, is an excellent criterion of its probable future strength. No cider, a wine pint of which, when expressed from the apple, does not weigh 17 ounces, or more, can be strong cider; nor will it keep over the first summer. Good cider weighs, when recently expressed, from 17 ounces and a quarter to 17 and a half, and its weight is a sure indication of the quantity of saccharine matter which it contains, and which, in the fermentation, is of course converted into alcohol.

Every utensil, as the mill, press, tubs, casks, and pails, should be properly cleaned, by soaking and washing.

Several methods are practised for converting apples into *pommage;* the two most in use are a bruising-stone, with a circular trough, and the apple-mill. The best internal construction of a mill, seems to be that which has two pair of rollers, (many mills having only one pair,) the upper pair being stuck with coggs and dags, and the under pair being of very hard wood, turned smooth, and worked with coggs only. The upper rollers grind the apples to a coarse pulp or *pommage*, and the under one squeezes it to a fine pulp.

The apples being, by either method, properly bruised, the *pommage* is carried to the press, and a square heap, or cheese, (as it is called,) is made by alternate layers of it, with clean wheat straw; or by putting it into hair bags, or hair cloths.

The cheese, after standing for some time, is to be pressed down *gradually*, till at length the greatest possible pressure is applied, and all the juice pressed out. The juice is then strained through a sieve, and put into the cask destined to receive it. The cask should be full, that when the fermentation takes place, the feculent matter may flow over at the bung-hole. As soon as the fermentation is sufficiently completed to permit a bung in the hole, it should be put in at first slightly, and after a few weeks tightened. The liquor should then not be disturbed till it is wanted to be drunk.

The nature of the expressed juice of apples induces it, when at rest, and in almost every temperature above the freezing point, to go into the vinous fermentation. To expect to have at once a strong and sweet liquor is impossible. The sugar becoming decomposed during the fermentation forms alcohol; and if an attempt be made to prevent the decomposition by racking, or other art, the fermentation again commences. The sweet cider met with in London, and other cities, are of this description.

Any addition of sugar to good cider, immediately on its being pressed, does not improve the taste of the liquor. It improves its strength, and an addition of four ounces or more of sugar, to every gallon of poor cider, that is, one which weighs less than 17 ounces to the pint, will be of advantage to it, provided it be mixed at the time it is made.

For labouring men, and for summer beverage, it is far superior to any kind of malt liquor, and its acid is manifestly advantageous in the quenching of thirst. Good effects have arisen, too, from moderate doses of good cider in the secondary fever, and debility after the measles.—*Jennings's Family Cyclopædia.*

Mr. Knight says, that the strongest and most highly-flavoured cider which has been obtained from the apple, was produced from fruit growing on a shallow loam, on a limestone basis. All the writers on the subject seem to agree that calcareous earth should form a component part of the soil of a cider-orchard. Coxe says, the soil which yields good wheat and clover, is best for a cider-orchard. Mr. Buel states, "My own observation would induce me also to prefer a dry and somewhat loose soil, in which the roots destined to furnish food for the tree and fruit may penetrate freely, and range extensively in search of nutriment."

For fine cider, Knight recommends that the fruit be ground and pressed imperfectly, and that the pulp be then exposed 24 hours to the air, being spread and once or twice turned, to facilitate the absorption of oxygen; that it be then ground again, and the expressed juice be added to it before it is again pressed.

The vinous fermentation commences and terminates at different periods, according to the condition and quality of the fruit, and the state of the weather. According to Knight, the best criterion to judge of the proper moment to rack off, (or draw the liquor from the scum and sediment,) will be the brightness of the liquor, which takes place after the discharge of fixed air has ceased, and a thick crust is collected on the surface. The clear liquor should then be drawn off into another cask. If it remains bright and quiet, nothing more need be done to it till the succeeding spring; but if a scum collects on the surface, it must immediately be racked off again, as this would produce bad effects if suffered to sink.—Among the precautions used to prevent excessive fermentation is *stumming*, which is, fuming the cask with burning sulphur. This is done by burning a rag, impregnated with sulphur, in the cask in which the liquor is to be decanted, after it has been partly filled, and rolling it, so as to incorporate the liquor with the gas. A bottle of French brandy, or half a gallon of cider-brandy, added to a barrel, is likewise recommended, to be added as soon as the vinous fermentation is completed.

In a good year an orchard of an acre yields 800 gallons of cider, and on an average 400 gallons, *i. e.* 9 quarts, or 9 pints per day for family use. If sold, the price is from 4*d.* to 1*s.* per gallon, according to season, producing about 10*l.* profit. But if the kinds are such as can be sold for table or domestic use, or be made into apple-butter, the profit is 20*l.* per acre.

*Strong Cider.*—In the frosts of January place a number of hogsheads of cider upon stands out of doors. The frost turns to ice the upper part of the contents of the hogshead, and by a tap draw off the bottom which is not frozen. This is the spirituous part, and as strong as the strongest beer can be made. The frost has no power over this part; but the lighter part which is at top is frozen into ice. This, when thawed, is very weak cider.

CIMOLIAN, or Argenterian earth, is porphyry decomposed by volcanic heat, and used in the Levant as a superior Fuller's earth.

CINCHONA, or Bark, in Peru called gannanaperide, is one of the most important additions to the Materia Medica known in modern times. There are 24 or more species, but the *C. lancifolia*, *C. oblongefolia*, and the *C. cordifolia* are the kinds in general use. The first is the *pale* bark, the second the *red* bark, and the third the *yellow* bark. By analysis in the first is found an essence called cinchonia, and in the others, an essence called *quinia*; they contain, respectively, 77 carbon, oxygen 8, hydrogen 6, and nitrogen 9; and carbon 74, oxygen 7, hydrogen 9, and nitrogen 11, nearly. They unite with sulphuric acid, and their sulphates, especially that of quinia, are now generally preferred to the gross barks. The preparation is in crystals of 62 quinia, 14 sulphuric acid, and 24 of water. The constitutional effects are tonic and antispasmodic, with general vigour of system, counteracting intermittent fevers, erisipelas, &c. &c. The dose is from 1 gr. to 4 grs. as pills, with crumb of bread, 3 times a day, or in a wine-glass of the acidulated infusion of roses. The sulphate is soluble in 30′ parts of boiling water, or 600 parts at 60°.—*See* QUININE.

*Cinchona Tincture.* Two pounds and a half of alcohol, and four ounces of Peruvian bark.

*Cinchonine.* Boil Peruvian bark in alcohol till all the bitterness is extracted; distil dry; add boiling water; acid with muriatic acid; then calcined magnesia; boil till the liquor is clear; cool, filter, wash the filter with cold water, dry, boil in alcohol till all the bitterness is extracted; decant, and in cooling the cinchonine will crystallize. Purified by solution in a very dilute acid, and add subcarb. of potass; white, crystalline, scarcely soluble in water, or in ether: used in combination with sulphuric or acetic acid.

CINNABAR is found native, or is prepared. It is a combination of mercury, sulphur, and oxygen, and made by subliming *Ethiop's mineral* at a red heat, by which the vermillion powder is produced.

Cinnabar is found in the state of ore in almost all quicksilver mines, sometimes in veins, sometimes disseminated, sometimes in grains, and sometimes crystallized. Specific gravity, 5·419, to 10·285; brittle, and of a deep red color when in the lump. It yields its sulphur to the fixed alkalies, lime, other earths, and several of the metals: of these iron is the most convenient, as affording the means of procuring the mercury in a state of purity, owing to the sulphur combining with the iron.

*Cinnabar*, or red sulphuret of mercury, is made by mixing 19 of mercury with 3 of melted sulphur, triturating, and subliming; or by heating Ethiop's mineral with a coat of water, and stirring as it passes from black to brown and red.

CINNAMON, is the under bark of a tree of the bay tribe, (*laurus cinnamomum.*) It attains the height of 20 or 30 feet. There are two principal seasons of the year, in which the Ceylonese enter their woods for barking the cinnamon-trees. The first in April, and the last in November. The branches of three years' growth are cut down, and the outside pelicle of the bark is scraped away. The twigs are then ripped up lengthways with a knife, and the bark is gradually loosened, till it can be entirely taken off. It is then cut into slices, and, on being exposed to the sun, curls up in drying. The smaller pieces, or *quills*, as they are called, are inserted into the larger ones, and these are afterwards tied into bundles. The cinnamon is examined and arranged according to its quality, by persons who, for this purpose, are obliged to taste and chew it. But few persons are able to hold out more than two or three days successively, as the cinnamon deprives the tongue and lips of all the mucus. The bundles are made up to the length of about 4 feet, and weigh about 88 lbs. each. From the roots of the trees numerous off-sets shoot up. These, when they have attained the height of 10 feet, are cut down and barked, being then about the thickness of a common walking stick, and the cinnamon which they yield is much finer than any other. Jamaica grows it on different parts of that island. In Ceylon, the trees are so common as to be used for fuel, and the smell, particularly of the thinnest pieces, is delightfully fragrant. An oil is extracted, which is heavier than water, and this is prepared in Ceylon, almost wholly from the small and broken pieces. The cassia bark is often substituted for cinnamon, to which it has considerable resemblance, although in its qualities it is much weaker, and distinguishable by its slimy taste. The virtues of cinnamon are not confined to the bark. The leaves, the fruit, and the root yield oil of considerable value. At Ceylon it is merely made into candles.

The oil is made by maceration in sea-water for 2 days, and distilling gradually. It is used for cramps in the stomach, and windy colic, from 1 to 3 minims on a piece of sugar. The infusion is employed in various mixtures, and the bark in many culinary preparations.

*Cinnamon-water.*—To 1 quart of alcohol, (or proof spirit,) add 3 ounces of cinnamon.

*Compound Tincture of Cinnamon.*—In 2 pints and a half of alcohol, infuse 2 drams of long pepper, and 1 ounce of cinnamon, and of lesser cardamom seeds.

*Cinnamon-Tree.*—(*See* CINNAMON.)

The *Wild Cinnamon.* (*Laurus cassia.*) Leaves bitter.—*L. Japonica.* The leaves sold for cinnamon leaves, but very different in taste.

*Isle of France Cinnamon*, *Peruvian cinnamon.* Barks aromatic, astringent.

CIRCLE. Every circle is to its diameter as 22 to 7, or as 1 to 3·14159.

Every circle is considered as 360°, and quadrant 90°.

Every arc of a circle is the product of 0·01745, the degrees and the radius.

An arc of 57° 18' is equal to the radius.

The chord of 60 degrees is equal to the radius.

CIRCULAR SAWS, are saws which revolve upon an axis, and are preferable to straight saws, because they act continually in the same direction, and no force is lost by the backward stroke. At the same time, they can work with greater velocity, and, therefore, cut more smoothly. Their size, however, is limited, because they waver and bend out of the proper plane if made too large, and if they were made so as not to waver, they would be too thick. Slitting of timber, therefore, is not often performed with them, but they are much used for cutting thin layers of mahogany for veneering, for, in this case, the saw can be sufficiently strengthened towards the centre. Great velocity increases much the steadiness of a circular saw.

**CIRCULAR STERNS** have been applied to the Chichester, of 52 guns, at Woolwich. The advantages of the circular over the square stern are, that in action it leaves no point of impunity in attack or defence, and that the vessel's frame is bound firmer together, thereby adding force, with reference to the guns, and strength, as regards architecture. The stern of the Chichester is more roomy than if fitted with a square stern; it houses the rudder-head, and works her stern guns equally well with those on the broadside.—*See* Ships.

**CIRCULATING MEDIUM** means the medium of exchanges, or of purchases and sales, whether this medium be gold or silver coin, paper, or other article. All the tribes of savages hitherto discovered, refer to some article in estimating the value of the various commodities which compose their capital. The Krees Indians use beaver skins as their medium, and estimate the value of things by a certain number of their skins. The Virginians, in the earlier periods of their colonial history, estimated value by pounds of tobacco. In some parts of Africa, small shells and cowries are the medium of exchanges. But, from the earliest times, the precious metals, where they could be had, have been preferred, because their weight and fineness could be more accurately ascertained than those of any other article, and thus comprise a sufficient value in a small compass and weight to be a convenient medium. Platina would be as convenient a medium as either gold or silver; but it has not as yet been produced in sufficient abundance.

But other kinds of currency apparently answer the purpose of a circulating medium, and which have very little intrinsic value. A small piece of paper, not worth intrinsically half a farthing, by convention, and by law, passes for many thousand pounds; consequently, intrinsic value is not an essential quality in public currency. It passes for currency, because it bears a promise from a creditable party, that the holder shall be entitled to a certain number of pounds, *i. e.* a certain quantity of gold and silver, or equivalent article. If this promise is deemed valid, then the real medium is paper, much more convenient for transportation, and equally convenient in all other respects, and it is a great object in every community to gain the advantage of multiplication. Formerly, the sovereigns of Europe had a practice of debasing the current coin, when they wished to levy a tax in disguise, so as to make the copper, with which they alloyed the silver, pass in the value of silver. But, in modern times, instead of debasing the coin, the usual resort is to a government bank or to government paper. Unhappily, bad faith has usually marked all these transactions, and even the British government, by its arbitrary manœuvres after the panic of 1825, caused a loss of countless millions to the British people. If paper were issued on real security, accessible to the holders, if needful, and if government would be wise and honest, a paper circulation is, in all respects, as good as one of gold. But the ultimate security is the criterion, and without this guarantee no man ought to take paper. At the same time, as it is profitable to issue paper, so security for it would always be given, and, when not to be obtained, there is danger of fraud. Hitherto, all governments have cheated their subjects by paper-money; so that, in spite of its public conveniences, it is viewed with suspicion. At the same time, it would be a luxury to issuers to be allowed to give security, as a protection against panics and alarms. There ought to be a public office in all countries where paper-money is issued, to receive security, to which office the holders might resort in case of failure.

**CISTUS**, or Rock-rose, a genus of plants, chiefly white, purple, and yellow. Each flower lasts only a single day, but there is a perpetual succession of new ones from the same plant for six weeks or two months. The greater part of them may be propagated either from seeds or cuttings. The dwarf Cistus, most frequently met with in gardens, requires no other care than to be kept clear from weeds.

**CITRIC ACID** is made from the juice of lemons and limes, by adding lime to form a citrate of lime, and then separating the lime with dilute sulphuric acid.

Citric acid is that which gives their acid taste to lemons, citrons, limes, and many similar fruits. The acid has several uses in the arts, which renders its proper preparation an object of importance. It possesses the property of speedily dissolving oxides of iron, which cause linen to be iron moulded; and hence is used for the purpose of getting rid of these spots. The dyers use it, for no other acid can be employed with such success in enlivening the colors given by safflower: it also forms with grain tin a liquor which, with cochineal, produces a scarlet color superior to the usual dye, especially with silk and morocco leather.

Citron juice is still exported in large casks from Italy to Germany, and the north of Europe, and formerly to England, when it was an article of the Materia Medica, under the name of *acetositas citri*; the juice thus kept deposits much, from which, when the acid liquor has been drawn off, a species of essence of lemons is distilled; the clear liquor racked off may be kept for a long time, especially if covered with a little sweet oil, and stored in a cool cellar.

West Indians are in the habit of adding rum to the juice of limes, a small species of lemon, with a view of allowing it to be transported to Europe: but this addition prevents the juice from being used for the manufacture of citric acid, and it can only be employed for making shrub or other liqueurs.

The specific gravity of good citron juice is from 1·0312 to 1·0625: the degree of sourness may next be determined by adding to a certain quantity of it the necessary quantity of crystallized, but not powdered, carbonate of soda, to saturate it.

The addition of nitrate of barytes will show if any oil of vitriol has been added, by producing a sediment; a solution of silver in a nitric acid will, by the same means, shew if muriatic acid has been added.

It may be converted into citrate of lime for exportation, by stirring it continually, while a sufficient quantity of powdered chalk or whiting is added to saturate it, of which it generally takes about one-sixth of its own weight; and then, letting it settle until it is clear, the liquid is poured off, and boiling water poured on the sediment, and the whole being well stirred, it is left to settle and then poured off; this washing is repeated until the water comes off clear.

From this citrate of lime, either fresh, or dry as imported, the citric acid is easily obtained by the addition of sulphuric acid, weakened with four times its weight of water, for fresh moist citrate, or with at least six times for dry citrate. If fresh citrate is used, it will take about nine pounds of sulphuric acid for every ten pounds of chalk or whiting that was used in preparing it: the dry citrate will require about 45 lbs. of oil of vitriol to each 100 lbs.

The acid and water being mixed together, are to be poured gradually upon the citrate of lime, and the whole kept constantly stirred; towards the end the mixture becomes more liquid than before, and the sulphate of lime appears to separate from the liquor in crystalline grains. When the whole of the acid is added, the mixture is left for some hours, but is stirred occasionally, and is afterwards essayed, whether too much or too little sulphuric acid has been added.

The evaporation is first performed in a leaden boiler, until about four parts in five of the liquor have exhaled: it should then be removed to a stone-ware or pewter vessel, set in a copper of water, that the heat may be better regulated than by an open fire. The evaporation is to be carried on carefully until the liquor is nearly covered with a skin of fine crystals, when the liquor is to be left to cool. The first crop of crystals is usually dark brown; but if the citrate of lime has been well washed, of a pale brown: by dissolving them two or three times in as little water as possible, straining the solution through a skin of wash-leather, and re-crystallizing, they become white.

Ten, fifteen, and twenty-five grains of citric acid neutralize a scruple of carbonate or sub-carbonate of potass, and sub-carbonate of ammonia.

*Citric acid* may be made from the lemon, lime, cranberry, bird's cherries, nightshade berry, and hips of briars.

*Lime juice* is an impure citric acid, prepared as a preventive of scurvy in sea voyages. The limes come in between the latter end of October and the middle of November; and, as they arrive successively in the market, the juice is to be squeezed into earthen vessels holding about 15 gallons, and in the evening poured into large casks or pipes, from which rum, brandy, or madeira has been lately taken out. But, before the juice be poured out of the earthen pans into these casks, into which it is to be collected for purification, a red-hot iron bar, about 8 inches long, 4 inches broad, and 2 inches thick, having an iron chain fixed to it by a hook, is twice quenched in it, turning it equally round on all sides. When the cask, in which the juice is collected in this manner, is nearly full, there is put into every maund, or 10 gallons of juice, half a gallon of Bengal rum, full-proof, and it will then settle and clarify itself by the beginning of December, when it may be drawn off for use, either into small casks or bottles.

*Citric acid from Gooseberries.*—The gooseberries are to be bruised and fermented: the alcohol formed, distilled off, and the residue pressed to extract the liquid. The latter is to be heated, and carbonate of lime added as long as effervescence is occasioned. The citrate of lime is then to be collected, drained repeatedly, washed, and then pressed. It is still colored and mixed with malate of lime; it is to be mixed with water until of the consistence of thin syrup, heated, decomposed by sulphuric acid, and the whole diluted with twice its weight of water. The fluid separated from the precipitate is to be again treated with carbonate of lime; and the precipitate, when collected on a filter, is to be well washed, pressed, and a third time decomposed by sulphuric acid. The clear liquor now obtained is to be boiled with animal charcoal, filtered, and evaporated. When sufficiently concentrated, it must be allowed to deposit, and the fluid, when poured off, be put into stoves heated to between 68° and 77° Fahr. Crude crystals of the citric acid will be thus obtained; they are to be drained slightly, washed, and re-crystallized.

Besides lemons, *Citric acid* may be made from the cranberry, bird-cherry, dog-rose, and bitter-sweet.

Nine or ten drachms of citric acid in a pint of water makes rich lemon-juice.

10 grains make effervescing draughts with carbonate of soda, and 15 with that of potass. A scruple, or 20 grains, in a pint of water, sweetened with sugar rubbed on peel, is a delightful cooling drink.

CITRON, is a species of lemon, larger, and less acid, with a rind more aromatic. It is imported in its candied state, chiefly from Madeira.

CIVES.—Delicate young leaves used in salads.

CLARIFYING, is performed, while boiling, with whites of eggs; which, after beaten, are stirred into the liquor, and the impurities coagulate with the egg, and float as scum. Wines and beer are clarified by stirring a solution of isinglass in the cask, and, in sinking, it carries down the impurities.

*Carded cotton* is reserved for filtering such fluids as are considered precious, whether on account of the difficulty of procuring them, or of the small quantity with which we may be provided. In order to form this filter, *carded cotton* or *tow* is introduced into the throat of a glass funnel, and stuffed in with a cane glass, so that it forms a kind of slightly-compressed cork; the fluid which is to be filtered is then poured into the funnel. The filtration takes place drop by drop, and after the first drops have been separated and poured back again, those which follow are always clear. The essential oils may very conveniently be filtered by this means, without danger of waste.

The acids, especially those that are in a concentrated state, can only be filtered through *pounded glass;* but this substance must not be used till it has been washed several times; at first, with a large quantity of water, and afterwards with an acid, in order to deprive it of the earthy or other foreign particles that might be dissolved by the acids which are to be filtered. These filters are formed in a funnel. The great art that it required, in order that they may produce this effect is, first, to fix some fragments of glass in the throat, afterwards to add other smaller fragments, and thus to continue always diminishing the size of the fragments, till a thickness of 3 or 4 inches has been formed; the upper layer of which ought to be glass reduced to a fine powder.

*Clarification by rest* is sometimes subject to several inconveniences, the chief of which are, that it requires a considerable length of time, and that during this interval the formation of new products often takes place.

The effect of *albuminous and gelatinous matter* is principally remarkable in the vinous liquids. They are employed when it is required to fine wines and other fermented liquors; that is to say, when we wish to give them that high degree of limpidity which they can rarely acquire and preserve by mere repose. In this case, nothing more is required than to dissolve eggs, isinglass, hartshorn shavings, or any similar substance, in a small quantity of the liquid, and to mix this solution, cold, with the remainder. A short time after a kind of net-work is observed throughout the whole mixture, which soon contracting together, collects all the foreign substances from the fermented liquor, and carries them with it to the bottom.

In other instances, it is necessary to heat the liquids with which the eggs are mixed, and it is only at the moment of ebullition that the clarification takes place: most of the foreign-made syrups are clarified by this process, and no other has yet been discovered that produces a better effect.

Though the employment of albuminous matter for clarifying the juices of certain vegetables be of utility, it is, however, not without inconveniences. Amongst others, it changes the nature of these fluids in such a manner as partly to destroy their medicinal properties. It often happens to certain pharmaceutical preparations, such as decoctions of medicines, that, when in order to clarify them, recourse has been had to white of egg and heat, they are almost without effect, unless we take care to double the proportions of the ingredients that ought to enter into their composition.

*New cream* is employed with advantage in clarifying spirituous liquors, 1 or 2 spoonsful to the pint are sufficient to produce this effect in the space of a few hours in the cold. But as, in this clarification, some cheesy matters always remain suspended in this fluid, by reason of their great tenuity, it is necessary to separate them, at last, by filtration through a flannel bag, or through paper.

There are some fluids which, in order to become clear, require to be subjected to a degree of heat nearly approaching that of boiling water. These are principally such as are rendered opaque merely by substance, the solubility of which cannot become complete unless it be facilitated by raising the temperature of their solvent above its natural state. Many saline solutions stand in this predicament. Most of the fresh-expressed juices of vegetables may also be partially clarified by the operation of heat. Frequently, a slight degree of heat, applied to the expressed and filtered juices of certain vegetables, is sufficient suddenly to destroy their transparency; in this case, a flaky whitish substance floats in the liquid, and collects at the bottom of the vessel.

CLAY.—Mineralogists often limit the application of this word to the white infusible mass of indurated granite powder, from which porcelain is fabricated; and to the mass used in the moulding red bricks, and very coarse red pottery. But, a more extended application includes any mass of aluminous and other mineral products, which dilution with water, or moistening therewith to the consistence of dough, renders plastic and ductile; capable of receiving and retaining the various beautiful forms resulting from the exquisite touches of the modeller, and of being baked into a hard and durable substance.

Clays used for earthenware and porcelain, are the peculiar products of a few places; and appear to have been discovered by mere accident, without any positive criterion for their suitable composition; whether they had only a proper quantity, or more, or less than that, of silica, lime, magnesia, or barytes, which when baked would, by damp, be caused to fly in pieces; or, under the requisite heat, and on the application of water, might partially decompose. The brickmaker's *test* of the fitness of a clay is extremely uncertain. He takes up a little, and with spittle rubs it in his hand, and when the paste feels free from grit, he regards it as *good*.

In earthenware and porcelain several kinds are used; two from the south of Devonshire, named the *black*, and the *cracking;* two from the isle of Purbeck, in Dorsetshire, named the *brown* and the *blue;* and from the neighbourhood of St. Austle, in Cornwall, that particular kind which results from the decomposed granite, and from its peculiar use is named *china* clay.

The *black* clay is coloured by a carbonaceous ingredient, which wholly disperses, and leaves white the mixture of itself and other materials, by the heat of the oven in baking the pottery.

The *cracking* clay has its name from its great liability to crack while being baked, *bisquet;* but, when properly mixed with silica, its proportion of alumine causes the ware to appear very white.

The *brown* clay bakes extremely white, and never causes loss by cracking, but the small quantity of phosphoric acid which is present, renders needful a neutralizing power in some of the materials, during the bisquet baking, else the lead of the glaze will be thereby injured.

The *blue* clay bakes very white and compact, and often (as is the preceding likewise,) is introduced in the porcelain bodies.

The *china* clay is an impalpable and extremely white powder, but different quantities greatly vary in the proportions of their components, in reference to the talc and mica left, and the silica and alumine, which should ever be from about 40 silica, and 60 alumine per cent. The manner of its preparation necessarily abstracts most of the potass in the felspar, and in such degree diminishes the virtue of the clay.

When the clay, by analysis, proves deficient in its proportion of alumine and silica; has a grittiness to the touch, or is coloured by iron, pyrites, or some other deleterious mineral; either these last must be wholly abstracted by some particular process, or the whole must be provided for in calculating the proportions of those other materials which have components some way approximating.

Among the manufacturers of earthenware and porcelain, *clay* is the general name for the different compounds of earthy minerals employed by them. And, as each manufacturer endeavours to introduce into his *body* (the mass itself) some different proportions, there are numerous recipes, differing in excellence in consequence of some factitious circumstances. The following are, however, of general utility; and no manufacturer will be deceived in the results, when the combinations are made as directed. The proportions are centessimal, and carefully calculated.

Cream-colour bodies:

| | Parts | | | | | |
|---|---|---|---|---|---|---|
| Blue clay ...... | 24 | 37 | 34 | 66 | 56 | 67 |
| Black clay ...... | 24 | 18 | 16 | — | — | — |
| Brown clay .... | 16 | — | 20 | — | — | — |
| China clay ...... | 16 | 28 | 10 | 17 | 18 | 14 |
| Flint ........... | 16 | 14 | 12 | 17 | 18 | 17 |
| Cornish stone .. | 4 | 3 | 8 | — | 8 | 2 |

Blue printing bodies:

| | Parts. | | | | | | |
|---|---|---|---|---|---|---|---|
| Blue clay ......... | 35 | 40 | 27 | 33 | 50 | 39 | 56 |
| Black clay ......... | 15 | 15 | 11 | 12 | 20 | 13 | — |
| Brown clay ....... | 15 | 10 | 12 | 10 | — | — | — |
| China clay ......... | 12 | 17 | 22 | 23 | 10 | 19 | 27 |
| Flint ............... | 20 | 15 | 25 | 20 | 19 | 26 | 14 |
| Cornish stone ..... | 3 | 3 | 3 | 2 | 1 | 3 | 3 |

Porcelain, or china bodies:

| | Parts. | | | | | | Felspar. | |
|---|---|---|---|---|---|---|---|---|
| Calcined bone | 47 | 36 | 43 | 52 | 36 | 30 | Spar 17 | 22 |
| Cornish stone | 17 | 5 | 20 | 30 | 20 | 24 | — | — |
| Flint | — | 25 | 6 | 3 | 10 | 11 | 12 | 10 |
| China clay | 30 | 31 | 31 | 8 | 30 | 32 | 38 | 32 |
| Blue clay | 6 | 3 | — | 3 | 4 | — | 25 | 30 |
| Fritt, (*See* FRITT 3) | — | — | — | 4 | — | 3 | 8 | 6 |

The phosphate of lime being the required object, it is desirable that decayed bones should never be calcined. The bones are first boiled long, until all the gelatine is extracted; next they are calcined, and afterwards ground in a vat, similar to that for grinding flint. (*See* FLINT-GRINDING.)

There is also great attention required to the nature of the raw materials; because, in some of the clays, either silex or alumine is in excess, the former being best for porcelain, the latter for earthenware; and when an alkaline earth is present to the quantity of 6 to 12 per cent. the body is more easily vitrifiable, and requires more attention on the part of the firemen.

Ironstone (or stone) porcelain:

| | | | |
|---|---|---|---|
| Cornish stone | 48 | 38 | 39 |
| China clay | 28 | 27 | 32 |
| Blue clay | 18 | 20 | 20 |
| Flint | 6 | 15 | 5 |
| | | | 4 Fritt (No. 3.) |

[For proper glazes.—*See* GLAZE.]

Stone body, (for chemical utensils, &c.):—

| | | | |
|---|---|---|---|
| Cornish stone | 40 | 46 | 48 |
| China clay | 15 | 22 | 25 |
| Blue clay | 30 | 32 | 24 |
| Flint | 15 | — | 3 |

Stone body for mortars:

| | | | |
|---|---|---|---|
| Cornish stone | 26 | 38 | 20 |
| Blue clay | 55 | 40 | 30 |
| Flint | 9 | 10 | 40 |
| Black marl | 10 | 12 | 10 |

When properly baked, they are vitrescent, strong, durable, and very sonorous.

Egyptian black, or vitrified basaltes:

| | | | | |
|---|---|---|---|---|
| China clay | 40 | 56 | 2 | 23 |
| Blue clay | — | 18 | 46 | 40 |
| Calcined ochre | 38 | 18 | 44 | 25 |
| Manganese | 12 | 8 | 8 | 9 |
| Iron oxide | 10 | — | — | 3 |

Cane-colour (or pie) bodies:

| | | | | |
|---|---|---|---|---|
| Cornish stone | 17 | 20 | 20 | 25 |
| Black marl | 50 | 50 | 70 | 60 |
| Brown clay | 24 | 18 | 10 | 12 |
| Blue clay | 9 | 12 | — | 3 |

Jasper bodies:

| | | | | |
|---|---|---|---|---|
| Cornish stone | 30 | 18 | 30 | — |
| Sulphate of barytes | 25 | 16 | 45 | 40 |
| Blue clay | 15 | 8 | 20 | 30 |
| China clay | 15 | 10 | — | |
| Flint | *5 | 12 | 4 | 6 |
| Calcined gypsum | — | 16 | — | |
| Bone | — | 4 | — | 19 |
| Oxide of cobalt | 10 | 16 | 1 | 5 |

The barytes, gypsum, and stone, should be well ground together, previous to their being mixed with the other materials.

Pearl bodies:

| | | | | |
|---|---|---|---|---|
| Cornish stone | 50 | 60 | — | 50 |
| China clay | 18 | 10 | — | 25 |
| Flint | — | 5 | 7 | 5 |
| Blue clay | 28 | 20 | 37½ | 20 |
| Sulphate of barytes | 4 | 5 | 37½ | — |
| Bones | — | — | 18 | — |

The body will answer also for the fine figures on the jasper:

| | *Drab* and | *Lilac.* |
|---|---|---|
| Bones | 16 | 54 |
| China clay | — | 30 |
| Blue clay | 32 | 6 |
| Flint | — | 5 |
| Cornish stone | 45 | 2 |
| Sulp. of barytes | — | 3 |
| Cobalt oxide | — | 1 |
| Manganese | 7 | — |

The clays are first mixed, and the others are added. The varied position in the kiln will vary the tint.

Porous bodies (for *wine-coolers*, &c.)

| | | |
|---|---|---|
| Black marl | 84 | 90 |
| Blue clay | 10 | 5 |
| Flint | 6 | 5 |

DIPS for them.—The *slip* of any earthenware, tinted by cobalt, nickel, or iron.

Having mentioned the components of the *clays* which furnish the different *bodies* of the manufacture, it is proper to explain the manner in which they are mechanically conglomerated for the workman's use. This process is called SLIP-MAKING.

*The slip-house* is a long building, with the tiles half open. The *mouths* of the fire-places are outside at one end, alike for convenience of fuel, and to prevent soot or smoke affecting the mass inside. These mouths communicate with flues formed of particular-shaped bricks, whose lengths are from 14 to 18 inches, breadth 9 inches, and thickness 6, 4, and 3 inches, as placed nigher or more distant, in reference to the fire. These bricks are laid to form a long kiln, shaped like a brewer's cooling back, or trough, 30 to 40 feet by 5 feet, and 1 foot deep. For the preparation of some bodies, the kiln is lined with a thick coating of plaster of Paris. In a wider part are strong flags, for beating the mass as subsequently described, also a vat formed of flags placed edgewise, from 4 to 7 feet in its sides, and 2 to 4 feet deep.

Where the mixture of the components is wholly by manual labour, the natural clays are weighed, soaked in a vat, and carefully levigated and stirred until the finer particles are held suspended in the water, and the heavier sink to the bottom. The fluid *slip*, (so named because of its nature between the thumb and finger,) is then by pailsful passed through a fine lawn sieve, kept in motion, into a vessel properly marked by inches; or so formed as to be easily guaged. The flint and other components are next mixed well by *blunging* with a blade-shaped ash board having a transverse handle, for more readily lifting or pressing in the mass. When sufficiently mixed, either by a pump, or by pails, it is passed through another very fine lawn, upon the slip kiln, where it is kept in constant ebullition until a certain portion of the superfluous water is evaporated, and the mass is carefully turned over by the slip-maker, until he is satisfied that the whole is sufficiently plastic for the various manipulations of the potter. This mass, when taken off the kiln, is next tempered, beaten with a mallet, turned, beaten with a *tool*, (a small spade, or paddle) in small portions at each time, with all the man's power *slapped* on the heap, and left to mellow by a thorough cooling, prior to the workman taking what quantity he needs. The overplus is placed in a vault, and the longer it can there remain unemployed, and undergoing a peculiar chemical action, the better is it adapted for fabricating the best kind of vessels. Too often, however, instead of clay remaining in the vault any time, the workman obtains supplies from the slip-house of even a warm clay, though at much risk of injury to his labours. Wedgwood's jasper, &c. seldom can be allowed for use until many months after taken from the slip kiln.

But, where mechanical power is employed, (as at several of the manufactories,) to perform the most laborious processes, there are strong iron cones fixed, and inside are blades placed to radiate inward, and therein revolves a vertical shaft similarly armed with blades. The natural clays being thrown into the cone are severed and forced through an aperture in front near the bottom. Another cone prepares the mass instead of *slapping*. The clays are next thrown into a circular vat, 10 to 14 feet in diameter, and 3 feet deep, with a strong shaft working in it, on which are four arms, and ledges to carry *runners* of chest, (similarly to the flint mill.) This is supplied regularly with water, and at the upper edge is a spout, along which passes the excess of water with the suspended particles of the clay. Other spouts also are fixed, and at the end of each one or two lawn sieves, moved by machinery, alike abstract all impurities and gross particles, and discharge the mass, until it reaches the vat wherein all the other components are added.—*Shaw*.

*London Blue Clay* is dark blue; sometimes used for luting vessels in distilling acids; also used in pottery, for lining ponds, and for modelling.

*Devonshire Blue Clay* makes white solid pottery; and *Devonshire Black Clay* makes cream ware. *Devonshire Grey Clay* burns to a beautiful white, but cracks in firing.

*Common Clay* is drying, and used for bricks, &c. and common pottery.

*Cheam Clay* is a very light ash-color, compact, very smooth, burns pale white, and hard. It is used for the body of glazed gallipots.

*Argile de Saveignes* is blue, and tough; used to make the French stoneware, and *Argile des Forges-les-Eaux* is blue, and used to make glass-house pots, and stone-ware.

*Stourbridge Clay* is dark grey, and made into bricks for building glass-house furnaces, and also into crucibles for intense heats.

*Welsh Clay* is used to make fire clumps for the fire-rooms of steam-engine furnaces.

CLIMATE, depends on distance from the equator, the extreme length of days and nights, and the elevation above the level of the sea. The mean temperature of the earth is 50°, but the mean temperature of most places is that which prevails at 50 or 100 feet below the general surface of the country, while at depths of 10 to 40 feet the heat in summer is much greater at the surface than beneath, and in winter much greater beneath than at the surface. The mean heat at the equator is 84° 2′, at the tropics 76°, at lat. 43 is 58° 1′, in lat. 60 is 45°, and in lat. 75 is 35·5. A mean of 80° to lat. 16, yields all the spices, sugar, &c. A mean of 68 in lat. 33, yields rice, cotton, coffee, &c. A mean of 58° in lat. 45, yields vines, olives, wheat, figs, &c. A mean of 52° in lat. 52, yields all the productions of the United Kingdom. The solar light where he is vertical, is to that, at lat. 45°, as 750 to 666, and at 72°, as 375 or half, but the length of the days renders the annual heat higher in high latitudes. In all countries, elevation lowers temperature. A high mountain at the equator is ice and snow at the top, and 100° at the foot, with every intervening climate. The perpetual snow-point within the tropics is from 15 to 13,000 feet. But, in lat. 44, is 8000; lat. 59, 4000; and lat. 75, but 1000 feet. North America is from 5 to 8 degrees of Fahrenheit, colder than the same latitudes in Europe, equal to 9 degrees of latitude, that is, lat. 40 in America is only equal to 49 in Europe.

Climate is so much improved by the clearing of woods, that Europe in ancient times was as cold as North America in our age. France and Germany were by Roman writers described as in perpetual winter, and Britain then resembled the modern Newfoundland. Ovid refers to the freezing of the Euxine, and Horace says the Tiber, 300 years before his time, used to be frozen, and snow lie for forty days.

CLOCKS, were invented by some monk in the tenth century, but we are indebted for their perfection to Galileo's discovery of the equal oscillations of a pendulum, and Huggins's application of these oscillations to the scapement movement of a clock. The weight turns all the wheels; these continue the vibrations of the pendulum when begun by the hand, and the pendulum by the check and escape divides and regulates the time by its length, which for seconds is 39 inches and one-eighth, or for half seconds 9 inches three-quarters and one-eighth. There are seven wheels and five pinions in the frame of a common clock, besides the striking and extra movements.

We recommend to the clock-maker, says Mr. Partington, first to fix upon his number of vibrations per second with the pendulum, and then to calculate the true length of his pendulum, and exact value of his train, agreeably to the number of vibrations per second that he previously determined.

The most simple way of calculating the numbers proper for the movement of any clock, intended to shew seconds, is, by dividing it into three portions, and then by calculating the wheels and pinions for each separate portion, by a separate calculation, beginning at the bottom of the train; thus, we first fix upon the pinion of the hour arbor to be, suppose 8, which is a good practical number; and as our piece is to go eight days, we will make the fusee to revolve in 12 hours, which construction will require the great wheel on its arbor to be $8 \times 12$, or 96, because the pinion of 8 revolves, with the minute-hand on its projecting pivot, in one hour; hence, if we divide 192, the number of hours in eight days, by 12, the time of one revolution of the great wheel, the quotient 16 will be the number of effective spiral grooves necessary to be cut on the circumference of the fusee, in order that the piece may go just eight days.

This portion of the movement is not, however, called a part of the train, but only determines the time that the clock shall continue to go after each winding up of the maintaining power; and it is easy to conceive, that if a fusee or a barrel, with 24 turns of the catgut or chain, were placed on the hour arbor, the clock would go a natural day without the large wheel; and also, that if an intermediate wheel and pinion were placed on the arbor between the hour arbor and the great wheel, the time of going might be prolonged to 10, 12, or even 20 times eight days; but then the maintaining power must be proportionably increased, which circumstance renders such a construction by no means desirable.

The remaining portion of the movement is properly called the *train*, including those wheels and pinions only which are used for counting the vibrations made in an hour; the train is most easily ascertained by two calculations, one for the two wheels and two pinions which multiply the minutes into seconds, and the other for that wheel and pinion, or those wheels and pinions, which subdivide the seconds into vibrations; the former of these two portions of the train, like the first portion of the movement, or portion for the period of continuance, *is the same for all clocks*, let the time of vibration be what it may. The ratio of velocity to be gained by the pinion on the arbor of the seconds hand, compared with the wheel on the arbor of the minutes hand, is required to be as 60 : 1; which effect might be produced by one wheel of 300 teeth, and a pinion of five leaves, as is done in some French clocks; but the size of the wheel is cumbersome, therefore a pair of wheels, with a pair of pinions, one constituting a ratio of vulgar fraction equal in value to 8, and the other equal to $7\frac{1}{2}$, making $8 \times 7\frac{1}{2} = 60$, or any other two numbers making a similar product, will produce the same effect with fewer teeth; for if the pinions be each 8, the wheels, in this case, will be respectively 64 and 60, and, by the same process, if pinions of 10 had been chosen, the wheels would have been $8 \times 10 = 80$, and $10 \times 7\frac{1}{2} = 75$, which numbers would indeed have less friction than the preceding ones, by reason of their teeth acting at less depth, the diameters of the wheels remaining the same, and would moreover be capable of acting more behind than before the line joining the centres of the wheel and pinion; in like manner, pinions of 6 would require wheels of 48 and 45, and pinions of 12 wheels of 96 and 90.

The last portion of the movement, or second portion of the train, for a half-seconds pendulum, will require only one wheel of 60 teeth on the seconds arbor, properly shaped for the escapement; for as one tooth in the dead-beat and common anchor escapements escapes completely at two vibrations of the pendulum, 60 teeth will escape, that is, a whole revolution of the seconds hand will be made in 120 vibrations; if, however, the pendulum had been required to vibrate seconds, the wheel in question, called usually the swing wheel, in opposition to the crown wheel, which requires another escapement, would have demanded only 30 teeth for that purpose; and if three vibrations had been fixed upon, the number to correspond must have been 90, otherwise there must have been a wheel and pinion of the value of 3, like $\frac{8}{24}$, or $\frac{10}{30}$, in addition to the usual swing wheel of 30: or, which is the same thing, a wheel and pinion of the value of 6, like $\frac{8}{48}$, or $\frac{10}{60}$, must have been introduced between the seconds arbor and a pallet, or swing wheel of 15. Thus, all the variety in the calculation of trains, where seconds are indicated, is confined to the last portion of the movement, and the calculation itself so simple, that the mere altering of the numbers of the pallet-wheel will convert a clock with a seconds pendulum into one with half-seconds, and *vice versâ*.

The calculation of numbers suitable for an eight-days clock with a half seconds pendulum being thus readily obtained by three simple operations, the whole may be represented, and its value estimated again by a compound fraction, thus: viz. $\frac{8}{96}$ of $\left(\frac{8}{64} \times \frac{8}{60}\right)$ of $\frac{1}{60 \times 2}$ of 12 hours, or reduced is $\frac{8}{96} \times \frac{8}{64} \times \frac{8}{60} \times \frac{1}{60 \times 2} = \frac{512}{44236800} = \frac{1}{86400}$ in $12^{h.}$, or 86400 vibrations in 12 hours, the time of a revolution of the fusee, and great wheel, 96, on its arbor, and therefore $\frac{6400}{12}$, or 7200 vibrations, each of half a second in duration, in one hour, constitute the value of this train.

The calculation of proper numbers being made and noted down, the next stage of the work, says Mr. Partington, is proportioning the diameters of the wheels and of their respective pinions, so as to transmit the maintaining power from the fusee or barrel in an ordinary 30-hours clock, to the pallets, and thence to the pendulum, to compensate the loss of motion which, when unaided, it would sustain from friction and the resistance of the air.

The usual mode of sizing wheels and pinions, is, first to make both a little too big for the proposed calliper, and then, having rounded all the teeth of the pinion, and a few of the corresponding wheels, to diminish the latter in the lathe, or turning frame, gradually, until, by successive trials in the clock-frame, they are found to act at a proper depth, when placed in the pivot-holes previously made.

| Teeth in the Pinions. | Measures of the Wheel for a Diameter of the Pinion. |
|---|---|
| 3 | 3·5 |
| 4 | 4·1 |
| 5 | 4·8 |
| 6 | 5·5 |
| 7 | 6·1 |
| 8 | 6·8 |
| 9 | 7·5 |
| 10 | 8·1 |
| 11 | 8·8 |
| 12 | 9·5 |
| 13 | 10·1 |
| 14 | 10·8 |
| 15 | 11·5 |
| 16 | 12·1 |

The diameters of the wheels are usually made to diminish as the train ascends, probably because the force to overcome their inertia diminishes, and the friction also is less in fine teeth with slender pivots, than in coarse ones with thick pivots. Having taken the great wheel at 12 teeth per inch, measured at the pitch-line, we will take the centre wheel of 64 at 14, and the second wheel of 60 at 16, which will make something like a regular diminution in the sizes in the ascent of the train.

Table of Wheels and Pinions.

| Wheels. | | Teeth per Inch. | Acting Diameters in inches. | Geometrical Diameters measured from the Pitch Lines. |
|---|---|---|---|---|
| Great wheel | 96 | 12 | 2·60 | 2·55 |
| Its pinion | 8 | 12 | 0·273 | 0·21 |
| Centre wheel | 64 | 14 | 1·514 | 1·46 |
| Its pinion | 8 | 14 | 0·234 | 0·18 |
| Second wheel | 60 | 16 | 1·24 | 1·19 |
| Its pinion | 8 | 16 | 0·207 | 0·16 |
| Swing wheel | 60 | 16 | 1·24 | |

Pennington's practice was to add 2·5 measures of the geometrical diameter to the wheel, and 1·5 to the pinion, in watch-work, when the wheel is the driver; and 1·8 to each, when the pinion is the driver.

Berthoud's method of sizing pinions was as follows: viz.—

| No of Teeth. | *The full or acting Diameter of the Pinion.* |
| --- | --- |
| 4 | = two full teeth of the wheel, unrounded, and the space between. |
| 5 | = three teeth, rounded from point to point. |
| 6 | = three full teeth unrounded. |
| 7 | = three full teeth and a quarter of a space beyond. |
| 8 | = four teeth, ronnded, from point to point. |
| 9 | = somewhat less than four full teeth. |
| 10 | = four full teeth. |
| 11 | no measure given. |
| 12 | = five full teeth. |
| 13 | no measure given. |
| 14 | = six teeth rounded from point to point. |
| 15 | = six full teeth. |

The pinions in watches, he remarks, must be smaller in comparison with their wheels than in clocks.

The wheels, and the rest of the work, is contained in the *frame*, which consists of pillars and plates.

The main-spring lies in the *spring-box*.

That which the spring winds about, in the middle of the spring-box, is the *spring-arbor;* to which the spring is hooked at one end.

At the top of the spring-arbor is the *endless-screw*, and its wheel: but, in spring-clocks, it is a *ratchet-wheel*, with its *click*, that stops it.

That which the main-spring draws, and about which the chain or string is wound, and which is commonly taper, is the *fusee*. In larger work, going with weights, where it is cylindrical, it is called the *barrel*.

The small teeth at the bottom of the fusee, or barrel, that stop it in winding up, is the *ratchet*.

The lever which stops it when wound up, and is for that and driven up by the string, is the *gardegut*.

The parts of a wheel are, the *hoop*, or rim; the *teeth;* the *cross;* and the *collet*, or piece of brass, soldered on the arbor, on which the wheel is rivetted.

The ends of the arbor are called *pivots;* the holes in which they run, *pivot-holes*.

The guttered wheel, with iron spikes at the bottom, in which the line of an ordinary thirty-hour house-clock runs, is called the *pulley*.

The watch part of a movement is the *balance*, whose parts are the rim, which is the circular part of it; the *verge*, to which belong the two pallets, or leaves, which play in the teeth of the *crown-wheel*.

The parts of a pendulum are the *verge*, *pallets*, and *cock*.

The *crown-wheel* in old clocks, or the *swing-wheel* in royal pendulums, is that wheel which drives the balance or pendulum.

The *contrate-wheel* is next to the crown-wheel, *contrary* to those of other wheels.

The great wheel, or *first-wheel*, is that which the fusee, &c. immediately drives.

Next to it are the *second-wheel*, *third-wheel*, *&c.*

The *pinion of report*, is the pinion that is commonly fixed on the arbor of the great wheel, which drives the dial-wheel, and carries round the hands.

To strike the hours, the great or *first-wheel* is that which the weight or spring first drives.

In thirty-hour clocks this is called the pin-wheel; with pins it is called the *striking-wheel* or *pin-wheel*.

Next to this striking-wheel follows the *detent-wheel*, or hoop-wheel, in which is a vacancy, at which the clock locks.

The next is the third or fourth-wheel, called the *warning-wheel*.

Last, the *fly-pinion*, with a fly, or fan, to gather the air's resistance, and thus regulate the motion.

The *detents* are stops which, raised or let down, lock or unlock the clock in striking.

The *hammer tails* draw back the hammers.

*Latches* lift up and unlock the work.

*Catches* hold by hooking.

The *train* regulates the number of beats, or vibrations, which the clock makes in an hour, or any other certain time. Tke *snail* or *step-wheel* is found in repeating-clocks.

In the present state of the businesses of clock and watch-making they are divided into a great number of branches, and each, by devoting himself exclusively to that department, attains a greater degree of perfection.

The retailer, usually called clock or watch-maker, is little more than the examiner or putter together of the work furnished by different workmen.

The *brass-founder* casts the wheels, plates, and pillars.

The *wheel-cutter* divides and cuts the train, and forms the spiral on the fusee.

The *movement-maker* mounts the frame, in which he places the wheels and pinions.

The *spring-maker*, an artist of skill,

forges, shapes, and tempers the main-springs.

The *clock-smith* forges the steel and iron pieces for the arbors, pallets, hammer-work, &c.

The *bell-founder* casts and finishes the bells.

The *enameller* prepares the ground of the dial-plate, which is figured by another artist.

A *jeweller* is employed for the pallets and pivot-holes of the best pieces.

The *clock-case* maker includes several branches.

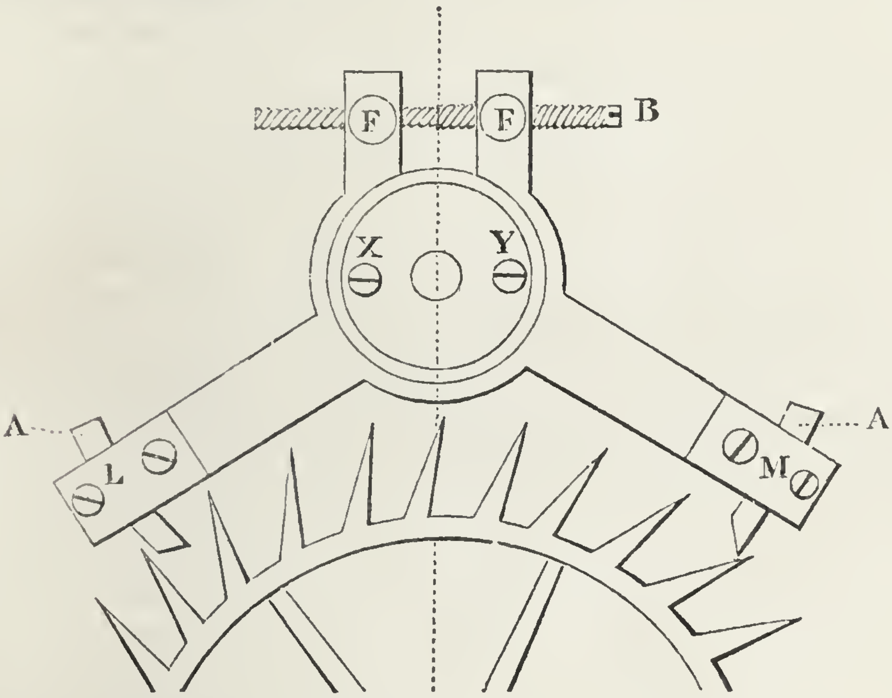
The *spinner of gut*.

The *chain-maker*.

The *finisher* makes the striking part, and finishes and polishes for sale.

The swing or scapement-wheel, connected with the pendulum, is furnished with a pair of pallets or catches. The wheel with teeth inclined on one side, and nearly perpendicular on the other side, holds one pallet while it releases the other. The pendulum detaches the caught pallet, and at each vibration the pendulum is raised at each side, the heights being equal, though the acting planes are differently inclined.

In Graham's pallets without recoil, the seconds-hand stands still after each drop of the pallets, and hence it is called *dead beat*, but the hand of a clock in the recoiling escapement is always oscillating backward and forward.




In Vulliamy's escapement without recoil the pallets, A A, are allowed to expand or contract by the motion of a double screw, B. To form the pallets, a ring of steel is, in the first instance, prepared, of the required size, and the arms, L M, turned with a circular groove to receive it. The ring may then be cut in short lengths, and inclined planes formed at the proper angle. The two arms of the pallet-frame are held together by the collet and screws, X Y, and the regulation is performed by the larger end of the screw, B, being furnished with a coarser thread than its other extremity, so that the disproportion between them is capable of producing the most delicate adjustment. The rests of the pallets are correct portions of circles, the centre of which circles is the centre of motion of the axis of the verge, and the pallets move in the same circles, and, consequently, there is no recoil in the escapement.

A pair of pallets always occupy the space or portion of the circle contained between the number of the teeth they take over, and one more ; thus, taking over two teeth, they require the space contained between three teeth ; were they to take over ten teeth, they would occupy the space contained between 11. In the one case the thickness of the pallets is without the teeth and the other within, and the thickness of each pallet being equal to half a space, the thickness of the two together must be equal to one entire space.

Pendulums measure equal time in clocks, but as they would stand from friction and resistance, the weight in the clock is a power which maintains the vibrations.

The series of wheels and the maintaining power are, in reality, appendages to the pendulum, every part of the machine being constructed in subservience to its vibration. It is the efficient measure of time, while the office of the wheels is merely to *record* its oscillations. The office of the wheels, as to the pendulum, is to prevent its coming to a state of rest, which it effects by repeated impulses at stated periods.

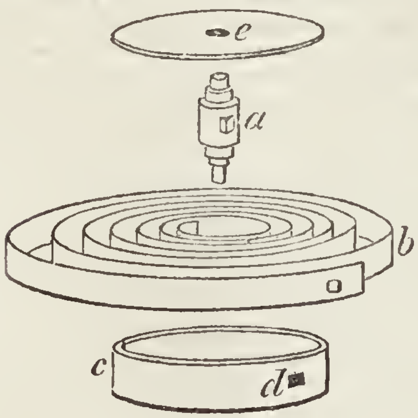
Pendulums only make isochronous vibrations when the arc is less than 8°. Any inequality is better corrected by the common scapement with plain faces to the pallets, than any refinement of cycloidal cheeks.

*Watches.*—When a suspended weight is used as the *maintaining-power* of a clock, the cord, by which it is suspended, is wound round a cylindrical barrel, and the suspended power never varies in its intensity, as it winds off in its descent.

A *spring* has, therefore been adopted, to supply the place of a suspended weight, in watches, and as the power of all springs vary with their distance from the quiescent position, the power derived from the force of a spring requires to be modified before it can become a proper substitute for a suspended weight acting constantly, with a slow and controlled velocity.

The contrivance called the fusee has been found of permanent use in equalizing the action and reaction of the spring.

A steel arbor, *a*, passes through the spring-box, *c*, and it has a square on its protruding end at *e*, on which a strong *ratchet-wheel* is inserted; and a catch, with a spring pressing on it, screwed to one of the plates of the frame of the works, always holds it fast in any position, so that the box *c* will turn freely, when urged round, without any motion of its arbor. Upon this fixed arbor is a stud within the box, on which the interior end of the spring, intended for the maintaining power, is hooked, by a hole, *d*, made near the extremity of the spring; while the exterior end of the same spring is pinned to the side of the box, the convex part of one suiting the concave part of the other, and the




breadth of the spring, *b*, being a gauge for the depth of the box.

The diameter of the box depends upon the length and thickness of the spring conjointly; the strength of the spring depends upon its breadth and thickness taken together, when at a given length: and the time it will continue to act at one coiling up, or winding, as it is called, will depend partly on its length, and partly on its strength. The relative forces of the spring, when coiled up, and when nearly relaxed, must also be ascertained by weights suspended by the chain that is wound round the exterior surface of the barrel; for, on the ratio of these extreme weights, or powers, depend not only the relative diameters of the opposite ends of the fusee, but also its actual length.

In order that the force applied to the escapement at each oscillation may not sensibly vary, it was found necessary to equalize, as much as possible, the variable forces of the main-spring in its different states of tension; and the most practicable way of doing this has been found to convert the cylinder, on the arbor of the great wheel, into a spiral like the frustrum of a cone, in order that, as the force of the spring becomes greater by increased tension, its action on the great wheel might be lessened in a similar proportion, by a gradual decrease of the radius of the fusee, round which the gut is wound, to impart the force thus modified. Every separate spring, therefore, has not only its average force proportioned to the escapement it is destined to actuate, when diminished by transmission through a given train, but requires its scale of varying forces to be nicely counteracted in every degree of tension by the SHAPE of the fusee; and this is done by means of a tool, called a fusee adjusting tool, which is nothing more than a lever with a sliding weight attached to the squared end of the fusee-arbor; for, when the weight on the lever is an exact counterpoise to the force of the main-spring in every part of the successive revolutions of the fusee, as the spring is wound up by the lever instead of a key, then the shape of the fusee is proper, but not otherwise.

The fusee is connected with the barrel by means of a line or chain, which winds in the spiral groove. From what we have already said, it will be evident that if the fusee was formed like the barrel of a weight-clock, the maintaining power must of necessity be unequal; but the spiral form ensures an equal maintaining power in every coil of the main-spring.

The principal frame for supporting the acting parts of a watch consists of two circular plates, the upper plate, and the pillar plate, from the circumstance of four pillars uniting the two plates and keeping them at a proper distance. By drawing out the pins of these plates the watch may be taken to pieces, the pivots of the several wheels being received in small holes made in these plates.

The maintaining power is a *spiral steel spring*, which is coiled up close, and put into a brass box called the *barrel*. The pivots of its arbor pass through the top and bottom of the barrel, and one of them is filed square to hold a ratchet-wheel, which has a click, and retains the arbor from turning round except in one direction. The two pivots of the arbor are received in pivot-holes in the plates of the watch. The top of the barrel has a cover or lid fitted into it, through which the upper pivot of the arbor projects, and the arbor of the barrel is a fixture. The click of the ratchet-wheel preventing it from turning round, and the interior end of the *spiral spring* being hooked, this arbor is stationary likewise.

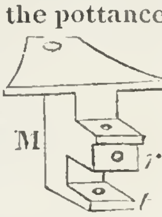
The barrel thus mounted has a small *steel chain* coiled round its circumference, and attached to it by a small hook of the chain which enters a little hole, made in the circumference of the barrel at its upper end; the other extremity of this chain is hooked to the lower part of the fusee, and the chain is disposed either upon the circumference of the barrel, or in the spiral groove cut round the fusee, the arbor of which has pivots at the ends, which are received into pivot-holes made in the plates of the watch; one pivot is formed square and projects through the plate for the key by which the chain is wound.

When the fusee is turned by the watch-key, it will wind the chain off the circumference of the barrel on itself; and, as the outer end of the spring is fastened to the barrel, and the other is hooked to the barrel arbor, which is prevented from turning by the click of the ratchet-wheel, the spring will be coiled up into a smaller compass than before, and by its reaction will, when the key is taken off, turn the barrel, and by the chain turn the fusee and give motion to the wheels of the watch. The fusee has a spiral groove cut round it, in which the chain lies; this groove is cut in such a form that the chain shall pull from the smallest part or radius of the fusee, when the spring is quite wound up, and therefore acts with its greatest force on the chain; from this point the groove gradually increases in diameter, so that as the spring unwinds and acts with less power, the chain operates on a larger radius of the fusee, so that the effect upon the arbor of the fusee, or the cog-wheel attached to it, is always the same.

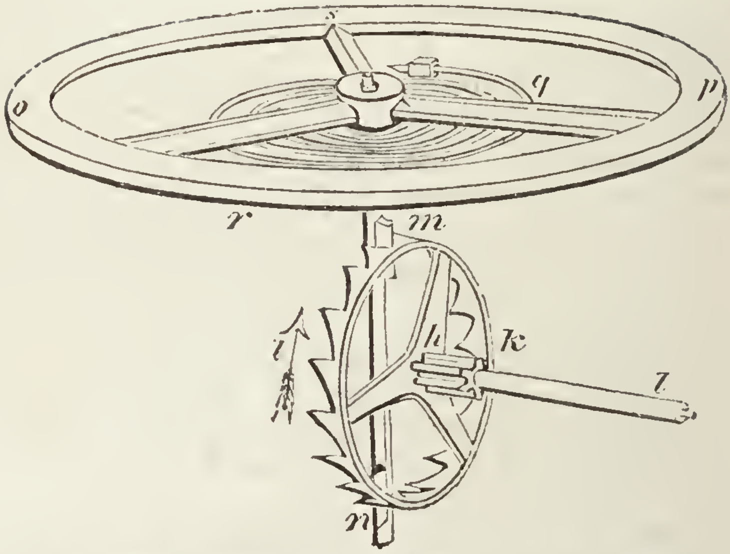
To prevent too much chain being wound upon the fusee, a contrivance called a *guard-gut* is added. It is a small lever, moving on a stud fixed to the upper plate of the watch, and pressed downwards by a small spring. As the chain is wound upon the fusee, it rises in the spiral groove, and lifts up the lever until it touches the upper plate, and it is then in a position to intercept the edge or tooth of the spiral piece of metal on the top of the fusee, and thus it stops it from being wound up any further.

The power of the spring is transmitted to the *balance* by means of several toothed-wheels.

*The great wheel* has forty-eight teeth on its circumference, which take into and turn a *pinion* of twelve teeth, fixed on the same arbor with the *centre-wheel*, which has fifty-four teeth to turn a pinion of six leaves, on the arbor of the *third-wheel*, which has forty-eight teeth, and is sunk in a cavity formed in the pillar plate turning a pinion of six, on the arbor of the *contrate wheel*, which has forty-eight teeth cut parallel with its axis, by which it turns a pinion of six leaves, fixed to *the balance-wheel*; one of the pivots of the arbor of this wheel turns in a frame, M, called the pottance, fixed to the upper plate, and the other pivot runs in a small piece fixed to the upper part, called the counter pottance, so that when the two plates are put together, the balance-wheel pinion may work into the teeth of the contrate wheel, as in the diagram at top of next page. The balance-wheel, *l*, has fifteen teeth, by which it impels the balance *o p*. The arbor of the balance, which is called the verge, has two small leaves or pallets projecting from it, nearly at right angles to each other; these are acted upon by the teeth of the balance-wheel in such a manner, that at every vibration the balance receives a slight impulse to continue its motion, and every vibration so made suffers a tooth of the wheel to escape or pass by, whence this part is called the escapement of the watch, and constitutes its most essential part.



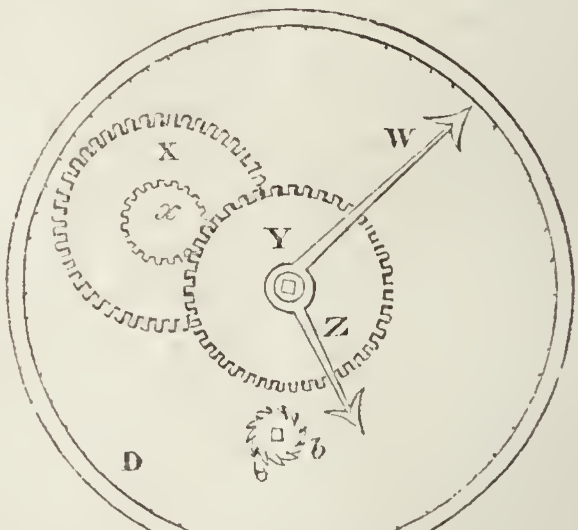

This wheel, *l*, is sometimes called the scape-wheel, or crown-wheel.




Every vibration of the balance suffers a tooth of the balance-wheel to escape and run down, by the constant action of the main-spring, and this motion is communicated to the hands of the watch on the dial-plate.

The hands are moved by the *central arbor*, which comes through the pillar plate and projects a considerable length, and it has a pinion of twelve leaves, called the *cannon pinion*, fitted upon it, the axis of which is a tube formed square at the end, to fix on the minute-hand, W, which fits tight upon the projecting arbor of the centre wheel, and therefore turns with it, but slips round to set the hands when the watch is wrong.

The cannon pinion is situated close to the pillar plate, and its leaves engage the teeth of the *minute-wheel*, X, of forty-eight teeth, which is fitted on a pin fixed in the plate. Its *pinion*, *x*, of sixteen leaves, is fixed to it, and turns the *hour-wheel*, Y, of forty-eight teeth. The arbor of this is a tube, which is put over the tube of the cannon pinion carrying the minute-hand, and it has the hour-hand, Z, fixed on it.




Thus, by the *cannon pinion*, which is to the *minute-wheel* as one is to four, and the pinion of this, which is to the *hour-wheel* as one is to three, the hour-wheel and its hand, though concentric with the cannon pinion and minute-hand, make but one revolution for twelve of the other. Therefore, one turns round in an hour, and the other turns round once in twelve hours.

To keep true time is effected, in watches, by increasing or diminishing the force of the main-spring, which increases or diminishes the arc that the balance describes, or by strengthening or weakening the pendulum spring, which will cause the balance to move quicker or slower.

The pendulum spring is fixed to a stud, upon the plate by one end, and is attached to the verge of the balance by the other.

The regulation is effected by means of what is called the *curb*; a small lever, projecting from a circular ring, which may be considered as its centre of motion, but perforated with a hole through the centre, large enough to contain the pendulum spring within it; a circular groove is turned out in the upper plate, nearly concentric with the balance, and the ring fits into this. Both are turned rather largest at the bottom, in the manner of a dove-tail; but the ring being divided at the side opposite to the lever, can be sprung up and rendered so much smaller as to get it into the groove, but being once in, the elasticity of the ring expands it, so as to fill the groove completely; in this state it may be considered as a lever which describes a circuit round the verge as a centre, and the end of it points to a divided arc engraved on the upper plate, at one end of which is marked F., and, at the other, S., denoting that the index or lever is to be moved towards one or the other, to make the watch move *faster* or *slower*. By shortening the length, the spring becomes more powerful, and returns the balance quicker, so that it will vibrate in less time; this is effected by moving the index towards F. On the other hand, turning the index towards S. lengthens the spring, by which it becomes more delicate, and less powerful, returning the balance slower.

Delicate watches have *jewelled pivot-holes* for the top and the bottom of the verge, to diminish the friction. These jewels are fixed in the bottom part of the pottance and in the top of the cock; each consists of two pieces, one of which has a cylindrical hole drilled through it to receive the pivot; the other is a flat piece, making the rest or stop which forms the bottom of the hole.

It is essential to a watch that it is not affected by variation of temperature; for the balance or the common watch is expanded by heat, and the pendulum spring is relaxed, both which alterations tend to diminish its rate in hot weather, and make it gain in cold weather. This defect is obviated by the compensation-balance.

The balance must, if possible, vibrate in the same time, whether it describes long or short arcs. Isochronism is attained by a proper adjustment of the pendulum spring, and by rendering the balance as little dependant on the influence of the maintaining power as possible, leaving it to its own free vibrations, and this is effected by the escapement.

A watch should go whilst winding up, so that it may not lose time, and this is accomplished by the going-fusee.

To make it keep the same time in all positions, the balance must be truly poised on its verge.

The compensation-balance consists in the employment of weights instead of a solid rim for the balance, and these weights are so fixed that they approach the centre of the balance in hot weather, and recede from it in cold, just as much as is requisite to compensate for the loss or gain of force in the pendulum spring.

A good escapement for a watch should only apply the impelling power to the balance at the moment when it is near the quiescent point, leaving it to finish the vibration by the combined action of the pendulum spring, and its own momentum alone, without being influenced in the period of its return by the action of the maintaining power. This is not the case in the escapement used in the common watch, which is called the crown-wheel escapement. But, to remedy this defect, many different kinds have been devised and employed by different artists, and with good effect: that which has been most generally employed in pocket-watches is called the horizontal escapement, from the circumstance of the last, or balance-wheel, having its plane horizontal or parallel with the balance and the other wheels.

That the watch shall continue its motion whilst winding up, is carried into effect by the going-fusee. By very simple mechanism, the main-spring, while the watch is going, acts on an intermediate short spring, which is called the secondary spring: it is constantly kept bent to a certain tension by the former, for the fusee has no communication with the great wheel except by this spring; when the watch is winding up, and the principal spring, fusee, chain, &c. ceases to act, the secondary spring, being placed on a ratchet-wheel, which is hindered from retrograding by a click, continues the motion of the great wheel without alteration.

*Springs.*—The spring of a clock is formed of the finest sheet steel, whilst that of a watch is prepared by hammering wire into a thin plate, and putting it into a clear furnace, in order to give it a suitable degree of heat. When that is acquired, it is taken out, and dropped into a kettle of oil, or warm mutton-suet; in consequence of which process, it possesses a degree of hardness little inferior to that of glass. After this it is reduced or let down to a fine violet or blue colour, in which state it becomes exceedingly elastic, so much so, that, to give it a permanently-angular form, it must be bent together, so that the sides come nearly in contact. After this it is planished, filed, and polished, and the surface being again blued, it is fit for use.

*Trains for plain Watches, with* 11 *Teeth in the Escapement-Wheel,—from* PARTINGTON.

| Numbers for the centre-wheel teeth. | Third-wheel pinions. | Third-wheel teeth. | Fourth-wheel pinion. | Fourth, or counter-wheel. | Escapement-wheel pinion. | Escapement-wheel. | Number of beats in one hour. | Fourth wheel revolves in. |
|---|---|---|---|---|---|---|---|---|
| 60 | 6 | 60 | 6 | 49 | 6 | 11 | $17966\frac{2}{3}$ | 36″ |
| 60 | 6 | 54 | 6 | 54 | 6 | 11 | 17820 | 40 |
| 60 | 6 | 56 | 6 | 52 | 6 | 11 | $17795\frac{5}{9}$ | $38\frac{4}{7}$ |
| 64 | 6 | 52 | 6 | 52 | 6 | 11 | $17626\frac{5}{27}$ | 39 |
| 58 | 6 | 56 | 6 | 53 | 6 | 11 | $17533\frac{26}{27}$ | $39\frac{705}{812}$ |
| 60 | 6 | 54 | 6 | 53 | 6 | 11 | 17490 | 40 |
| 62 | 6 | 54 | 6 | 51 | 6 | 11 | 17391 | $38\frac{22}{31}$ |
| 58 | 6 | 54 | 6 | 54 | 6 | 11 | 17226 | $41\frac{11}{29}$ |
| 58 | 6 | 55 | 6 | 53 | 6 | 11 | $17220\frac{5}{54}$ | $40\frac{182}{319}$ |
| 59 | 6 | 54 | 6 | 53 | 6 | 11 | $17198\frac{1}{2}$ | $40\frac{40}{59}$ |
| 60 | 6 | 54 | 6 | 52 | 6 | 11 | 17160 | 40 |
| 60 | 6 | 55 | 6 | 51 | 6 | 11 | $17141\frac{2}{3}$ | $39\frac{3}{11}$ |
| 61 | 6 | 55 | 6 | 50 | 6 | 11 | $17085\frac{35}{54}$ | $38\frac{5}{7}$ |
| 63 | 6 | 55 | 6 | 48 | 6 | 11 | 16940 | $37\frac{146}{383}$ |
| 59 | 6 | 54 | 6 | 52 | 6 | 11 | 16874 | $40\frac{40}{59}$ |
| 60 | 6 | 54 | 6 | 51 | 6 | 11 | 16870 | 40 |
| 61 | 6 | 54 | 6 | 50 | 6 | 11 | $16775\frac{4}{9}$ | $39\frac{52}{137}$ |
| 56 | 6 | 54 | 6 | 54 | 6 | 11 | 16632 | $42\frac{6}{7}$ |

*Trains for Watches to perform Minutes, Seconds, and Fifths of Seconds, with* 15 *Teeth in the Escapement Wheel, the fourth wheel revolving in* 60 *seconds, and* 18,000 *beats in the hour.*

| Numbers for the centre-wheel teeth. | Third-wheel pinions. | Third-wheel teeth. | Fourth-wheel pinion. | Fourth, or counter-wheel. | Escapement-wheel pinion. | Escapement-wheel. |
|---|---|---|---|---|---|---|
| 64 | 8 | 60 | 8 | 70 | 7 | 15 |
| 64 | 8 | 60 | 8 | 60 | 6 | — |
| 64 | 8 | 45 | 6 | 60 | 6 | — |
| 60 | 8 | 56 | 7 | 60 | 6 | — |
| 48 | 6 | 60 | 8 | 60 | 6 | — |
| 60 | 7 | 49 | 7 | 70 | 7 | — |
| 60 | 7 | 49 | 7 | 60 | 6 | — |
| 48 | 6 | 45 | 6 | 60 | 6 | — |

As every person has a watch, the best mode of reading the above is to set it open before him. Books can only exhibit general views, and engravings do not express objects clearly which are not on one plane. To make watches is a trade, only to be learnt by experience, and not by books.

As the pallets and the swing-wheel act and re-act, and a forced motion or obstruction is applied to the pendulum, so, to avoid this, mechanics have for a century endeavoured to improve scapements. The patents have been innumerable, and the results approach perfection, since this last year it was found at the Greenwich Observatory, that a chronometer made by Cotterell varied 7 lengths of a second, another by Frodsham but 0″·86, and one by Webster only 0″·89; consequently, in Webster's, a ship governed by it would be right within 350 yards. A second of time in this case is about the third of a mile. Hitherto, the annual errors had been from 1″ to 2″, but improvements have rapidly proceeded.

Harrison, who gained the longitude prize, made his clocks without friction, and they went without oil. His scapement had a double action or second moveable joint in their superior angle, so as to diminish their reaction on the pallets.

In Graham's dead-beat clock in the Royal Observatory, the pallets were oriental ruby, and the swing-wheel of hard steel, both requiring no oil. The angle of action was a third the vibration of the pendulum. Sometimes pallets are of agate.

The scape-wheel of Arnold's and of Earnshaw's pocket timekeepers has 15 teeth; those of the box timekeepers 13. Arnold makes the impelling teeth of the scape-wheel cycloidal, acting against a point. His detent unlocks inwards, or towards the axis of the wheel; Earnshaw's outwards.

There are so many contrivances, as the Remontoir, Mudge's, &c.&c. that we must refer for details to works on this art, especially as words alone could not make them quite intelligible to the reader.—*See Partington.*

The general rule for calculating the result of any train of wheels is to multiply the teeth in the *driving* wheels or pinions together, and divide the product by the multiplication of the teeth in the *driven* wheels or pinions, and the quotion is the number of the turns of the last of the set compared with one turn of the first. Thus, if 1 set is 60, 40, and 10, and the other 40, 24, and 6, it is $\frac{24000}{7680} = 3$ and nearly a third.

Millwrights apportion their succession wheels in odd numbers, so as to promote equal wear.

A pendulum is governed in its fall by the two motions of the earth. It is a portion of the 16·08725 ft. which a body falls through in a second. Its length for seconds at London is 39·1392 inches, or 39·1392 ten thousandths of an inch. Its length is as the square of the times, because the earth's surface's rotation in different times is as their squares, and the areas which pendulums generate are as the squares of their length. Thus, for half a second, the square is one-fourth, because the area is as the squares, hence the half-seconds pendulum is 9·7848 inches, and for three seconds would be nine times, or 352·2528 or 29 ft. 4 inches and one-seventh. At the equator the seconds pendulum is found to be but 39·017 inches, but in latitude 79°·50′ it is 39·21464 inches.—The centripetal force arising from an inequality of the earth's figure and motions is, therefore, less at the equator than at London, or in lat. 79°·50′. In consequence, in a second at the equator a body falls through but 16·045258 ft. but, at London, through 16·09953 ft. 30° of heat lengths it the 1–128 of an inch, or 8 vibrations in 24 hours.

The motions of a pendulum are, in fact, a miniature representation, and part and parcel of the two great mundane motions, and then, by their ingenious mechanism, clock and watchmakers carry the same into their pieces.

For every minute a clock varies in a day, a seconds pendulum must be altered $\frac{2}{37}$ or ·054 inch; a half-second pendulum, $\frac{1}{74}$ or ·00134.

A half-second pendulum lost 2″ in an hour, when placed in a vacuum: when the arc of vibration was increased to the same extent in the open air, it lost 6″ in an hour.—*Durham.*

The arc of vibration, when enlarged, occasions a loss of time, as the difference of the squares of two arcs × 1·644. Thus, if one pendulum vibrates 6° and another but 4°, the loss of time in the 6° will be $36 - 24 = 12 \times 1{\cdot}644$, or 16″·628.

Mr. Joseph Brown proposes that pendulums should be glass, the clock-plate spelter-solder, and the pendulum-balance lead. *Or*, the pendulum steel, the clock-plate hammered copper, and the pendulum-balance zinc. The expansions would then compensate.

Dr. Olinthus Gregory states, "that the most general remedy against the chief inconveniences of pendulums is, to make them long, to vibrate them in small arcs, and to have the bobs as ponderous as is consistent with the structure of the machine."

The time of pendulum vibration through the whole semi-circle, or 90°, is, to short vibrations of 5° or 6°, as 34 to 29.

Bernoulli observes, that the time of vibration in a circular arc may be found very nearly, by adding to the radius one 8-millionth of the versed sine.

Six balance-springs weigh a grain, and are worth £2 5*s*.

Springs may be made of gold with $\frac{1}{8}$ or $\frac{1}{4}$ its weight of copper; they are more elastic and more brittle than hard drawn steel wire, but less so than spring tempered wire.

The fixed cheeks which embrace the spring are raised by a bar of the same materials as the pendulum; but as much longer as to compensate for the expansion of the fixed substance.

A difference of 12′ in 24 hours has been observed in the different positions of a watch from magnetic action.

Balances of brass and steel, carrying a weight at the end, are best made by immersing the steel into melted brass, and turning it afterwards into a proper form.

Sometimes the compensation is made by the flexure of a compound bar, which only widens or contracts the distance of the two pins between which the spring plays.

Earnshaw professes to make the vibrations of the balance in short arcs more rapid than in larger, in order that the contraction of the arc, by the increased tenacity of the oil, may compensate for the unavoidable diminution of force of the balance-spring, which is relaxed by continual action.

Clocks resting against the same rail agree for several days, without varying a second; when separate they vary $1' 36''$ in 24 hours. A slower, having a longer pendulum, set the other in motion, by the intervention of the rail, in $16\frac{1}{3}'$, and stopped itself in $36\frac{2}{3}'$ : when the cases were connected by a bar of wood, the shorter pendulum was set in motion in $6'$, and the longer stopped in $6'$ more. On a stone floor the effects were slower. The shorter pendulum could not put the longer one in motion, because, as its vibrations became wider, they were still slower.

Berthoud found that a clock lost $297''$ in a day, by being more firmly fixed. Nicholson asserts, that the vibrations are more rapid as the fulcrum is firmer. The fulcrum must not be considered as a weight, but as a portion of an elastic substance.

During the winding up, the arbor carries round the ratchet, but turns freely in the first wheel, which is at rest. When the key is drawn out, the spring acts, and endeavours to unwind itself, and turn the arbor, but cannot, because a small spring makes the click catch into the teeth of the ratchet, so that it cannot turn without acting on the first wheel, and carrying on the whole train, which, in fact, is the movement of the watch.

Dr. Hooke, the inventor of watches, and many other things, established the law that the force of a spring is nearly in proportion to its distance from its resting position.

The balance-wheel weighs but 12 or 20 grains, and yet is the regulator of the scapement at 86,400 beats per day. It, therefore, is made to move 10 inches in a second. The oscillations urged by the spring are considered as being performed in equal times, whatever the arc described.

For 30-hours watches, the spring-barrel makes three or four turns for five or seven of the fusee. When the axis of the fourth (contrate) wheel has a seconds-hand, it revolves in one minute, to make 60 turns, for one of the centre-wheel. But when no seconds-hand, the contrate makes 60 turns in a minute. The scape-wheel makes the balance give four or five vibrations in a second.

The duplex-scapement, the detached-scapement, that of Earnshaw, Arnold, and Mudge; the lever, &c. are great and delightful improvements, but to be explained require plates, and more study than could requite the general reader.

Repeating watches, musical watches, eight-day watches, and others which do not require a key in winding, are among late improvements.

The patents are without number.

The original recoiling scapement, with the crown-wheel, is still used, in common watches. One-third of the circle is the usual vibration of the scapement. Graham's Horizontal Scapement is parallel to the other wheels.

The maintaining power, in common watches, is not one-fifth that of the regulating power of the spring.

Improvements have been effected in time-keepers, by a German of the name of Ulric. The irregularity arising from inequality in the power exerted by the main-spring, is prevented by the transfer of the motive power to a spring lever; which, capable of receiving only a certain portion of power from the spring, can only impinge on the balance axis with a certain and determinate force. This force, invariably the same, will, of course, always impel with the same effect. To secure an isochronous motion, the spiral or pendulum spring is made perfectly taper, an object obtained only through the medium of an elaborate tool, constructed for the express purpose of reducing them to this form. The variation between the sea and the land rates, in the best chronometers hitherto constructed, is remedied by the introduction of a balance, without iron or steel, consequently free from magnetic properties, or influence, yet possessing a compensating power, considerably more sensitive, and more active than any previously used, without any liability to permanent distortion of its true figure, by any transition from one temperature to another. The imperfection technically called *tripping*, and which is so frequently the cause of much error and miscalculation, is entirely prevented; nothing short of a violence sufficient to destroy the machinery of the time-piece, can cause it to trip. They admit of being cleaned without disturbing their rates, and, indeed, without disturbing those parts on which the accuracy of their movements depends; a quality which every one, who has the use or care of chronometers, will be able to appreciate. The most inexperienced person may safely be entrusted to wind them up, no change of position being necessary, and no possibility of overwinding or winding wrong existing. An increased solidity is introduced into every part, diminishing almost to annihilation the risk of accident by any ordinary occurrence, and, consequently, removing one very fruitful source of anxiety to the navigator.

*To destroy the smell of* CLOSE-STOOLS, &c.—Pour in some of a solution of half a lb. of sulphate of iron in a gallon of boiling water.

CLOTHES POWDER.—Mix 2 oz. of alcohol with 24 oz. of pipe-clay, 1 ½ oz. of iris-root, 1 oz. each of white pepper and of starch.

CLOTHES' BALL.—Mix 2 lbs. of pipe-clay, 4 oz. each of whiting and fuller's earth, 2 oz. of white pepper, and 4 oz. of ox-gall.

CLOTHING.—The only kind of dress that can afford the protection required, by the changes of temperature to which climates are liable, is *woollen*. Nor will it be of much avail that woollen be worn, unless so much of it be worn, and it be so worn, as effectually to keep out the cold. Those who would receive the advantage which the wearing of woollen is capable of affording, must wear it next the skin; for it is in this situation only that its health-preserving power can be felt. The great advantages of woollen cloth are briefly these:—the readiness with which it allows the escape of the matter of perspiration through its texture; its power of preserving the sensation of warmth to the skin under all circumstances; the difficulty there is in making it thoroughly wet; the slowness with which it conducts heat; the softness, lightness, and pliancy of its texture.

*Cotton cloth*, though it differs but little from linen, approaches nearer to the nature of woollen, and, on that account, must be esteemed as the next best substance of which clothing may be made.

*Silk* is the next, in point of excellence, but it is very inferior to cotton.

*Linen* possesses the contrary of most of the properties enumerated as excellences in woollen. It retains the matter of perspiration in its texture, and speedily becomes imbued with it; it gives an unpleasant sensation of cold to the skin; it is very readily saturated with moisture, and it conducts heat too rapidly. It is, indeed, the worst of all the substances in use.

Clothes should be so made as to allow the body the full exercise of all its motions. The neglect of this precaution is productive of more mischief than is generally believed. The misery and suffering arising from it begin in the cradle. When they have escaped from the nurses' hands, boys are often left to nature; but girls, as they approach to womanhood, are again put into trammels, in stays, and the bad consequences of the pressure of stays, if not immediately obvious, are not the less certain.

The skin, by increase of the perspiration, carries off the excess of heat; the lungs, by decomposing the atmosphere, supply the loss; so that the internal parts of the body are preserved at a temperature of about 98°, under all circumstances. In addition to the important share which the function of perspiration has in regulating the heat of the body, it serves the further purpose of an outlet to the constitution, by which it gets rid of matters that are no longer useful in its economy. The excretory function of the skin is of such paramount importance to health, that we ought, at all times, to direct our attention to the means of securing its being duly performed; for if the matters that ought to be thrown out of the body by the pores of the skin are retained, they invariably prove injurious. The insensible perspiration is the true excretion of the skin. A suppression of the insensible perspiration is a prevailing symptom in almost all diseases, and is the sole cause of many fevers. Very many chronic diseases have no other cause. In warm weather, and particularly in hot climates, the functions of the skin being prodigiously increased, all the consequences of interrupting them are proportionably dangerous. Besides the function of perpiration, the skin has, in common with every other surface of the body, a process, by means of appropriate vessels, of absorbing, or taking up, and conveying into the blood-vessels, any thing that may be in contact with it, as the nitrogen in antagonist action, to the oxygen fixed by the lungs. The skin is also the part on which the organ of feeling or touch is distributed. The skin is supplied with glands, which secrete from the nitrogen an oily matter, that renders it impervious to water, and thus secures the evaporation of the sensible perspiration. Were this oily matter deficient, the skin would become sodden, as is the case when it has been removed—a fact to be observed in the hands of washerwomen, when it is destroyed by the solvent powers of the soap.

The hair also serves as so many capillary tubes, to conduct the perspired fluid from the skin.

The three powers of the skin, *perspiration*, *absorption*, and *feeling*, are so dependent on each other, that it is impossible for one to be deranged without the other two being also disordered.

For, if a man be exposed to a frosty atmosphere, in a state of inactivity, or without sufficient clothing, till his limbs become stiff and his skin insensible, the vessels that excite the perspiration and the absorbent vessels partake of the torpor that has seized on the nerves of feeling; nor will they regain their lost activity till the sensibility be completely restored.

The danger of suddenly attempting to restore sensibility to frozen parts is well known. If the addition of warmth be not very gradual, the vitality of the part will be destroyed. This consideration of the functions of the skin will at once point out the necessity of an especial attention, in a fickle climate, to the subject of *clothing*.

CLOUDS, are vapours from the sea and earth, which ascend till condensed by cold, when they are precipitated to a level, in which their aqueous matter balances the atmosphere. The varied circumstances of heat and wind cause their various forms, as strata, or *stratus* clouds, rounded volumes or *cumulus*, and feathery or *cirrus*. The latter has great elevation; the two former, by interference, fall as rain, which is also promoted by sudden cold. They form conducting coats to plates or strata of the atmosphere, sometimes between one another, and at other times are one side of an electrified plate, and the surface of the earth is the other side. The restoration of such vast plates and surfaces is our lightning and thunder. The air is the disturbed electric, whose two sides, or surfaces, are in opposite states, and the clouds are like the tinfoil of any charged or excited plate.

In this electricity, as in all others, there is equal negative and positive. There is no fluid, but a mere change of relation, and oxygen on the positive surface, and nitrogen on the negative, seeking reunion with a force which arises from its vast extent in the stroke of restoration.

The heighth of clouds varies from a quarter of a mile to 3, 4, or 5, but averages 1 or $1\frac{1}{2}$.

Within the tropics the cumulus clouds are vast, richly-coloured, and splendid.

CLOUTED CREAM AND BUTTER. Mr. Carter has presented to the Society of Arts the following improved vessel for this purpose:—A four-sided vessel is formed of zinc plates, 12 inches long, 8 inches wide, and 6 inches deep, with a false bottom at one-half the depth. The only communication with the lower compartment is by the lip, through which it may be filled or emptied. Having first placed at the bottom of the upper compartment a plate of perforated zinc, the area of which is equal to that of the false bottom, a gallon (or any given quantity) of milk is poured (immediately when drawn from the cow) into it, and must remain there at rest for 12 hours; an equal quantity of boiling water must then be poured into the lower compartment, through the lip; it is then permitted to stand 12 hours more (*i. e.* 24 hours altogether,) when the cream will be found perfect, and of such consistence that the whole may be lifted off by the finger and thumb. It is, however, more effectually removed by gently raising the plate of perforated zinc from the bottom, by the ringed handles, by which means the whole of the cream is lifted off in a sheet, without remixing any part of it with the milk below. With this apparatus Mr. Carter has instituted a series of experiments; and, as a mean of 12 successive ones, he obtained the following results:—4 galls. of milk, treated as above, produced, in 24 hours, $4\frac{1}{2}$ pints of clotted cream, which, after churning only 15 minutes, gave 40 oz. of butter. 4 galls. of milk, treated in the common mode, in earthenware pans, and standing 48 hours, produced 4 pints of cream, which, after churning 90 minutes, gave 36 oz. of butter. The increase in the quantity of cream, therefore, is $12\frac{1}{2}$ per cent. and of butter upwards of 11 per cent. The advantage, however, is not limited to this increase of quantity, since it appears, that, in the above process, 10 or 15 minutes' churning is sufficient to produce butter, whilst it requires 90 minutes to produce the same effect with the common cream. Milk which has been subjected to this process is employed wholly in feeding pigs.

CLOVE BARK, or CULILAWAN BARK, is furnished by a tree of the Molucca islands. It is in pieces more or less long, almost flat, thick, fibrous, covered with a white epidermis, of a reddish-yellow inside, of a nutmeg and clove odour, and of an aromatic and sharp taste. It is one of the substitutes for cinnamon, but not much used. We find, also, in commerce, under the name of clove bark, another bark. It is in sticks two feet long, formed of several pieces of very thin and hard bark, rolled up one over the other, of a deep brown colour, of a taste similar to that of cloves.

CLOVER, a very numerous family, of no less than 55 species. Common red clover yields a larger product than any of the other sorts. The soil best adapted to clover is a deep sandy loam, which is favourable to its long tap-roots; but it will grow in any soil not too moist.

10 or 12 lbs. may be sown on an acre, if the soil be rich, and double that quantity if it be poor. The practice of mixing the seeds of timothy, rye, grass, &c. with that of clover, is wrong, because

these grasses neither rise nor ripen at the same time. Another practice, equally bad, is that of sowing clover-seed on winter grain before the earth has acquired a temperature favourable to vegetation, and when two-thirds of the seeds must perish.

For gathering clover-seed, the best machine consists of an open box, about four feet square at the bottom, and about three feet in height on three sides; to the fore part, which is open, fingers are fixed, about three feet in length, and so near as to break off the heads from the clover-stocks between them, which are thrown back as the box advances. The box is fixed on an axle-tree, supported by small wheels, with handles fixed to the hinder part, by which the driver, while managing the horse, raises or depresses the fingers of the machine, so as to take off the heads of the grass. There is another machine, called a *cradle*, made of an oak board, about 18 inches in length and 10 in breadth. The fore part of it, to the length of 9 inches, is sawed into fingers; a handle is inserted behind, inclined towards them, and a cloth put round the back part of the board, which is cut somewhat circular, and raised on the handle; this collects the heads or tops of the grass, and prevents them from scattering, as they are struck off.

White clover, *(trifolium repens,)* thrives best in light land. When sown by itself, it rarely grows tall enough to be well cut with a sythe; but, when mixed with timothy or green grass *(poa viridis,)* it makes excellent hay. Clover requires much attention to make it into hay. Its stalks are so succulent, that the leaves, which are the best part, are apt to crumble and waste away before the hay is well dried. It has, therefore, been recommended to cart it to the mow or stack before the stalks are dry, and either to put it up with alternate layers of hay and straw, or to salt it at the rate of from half a bushel to a whole bushel per ton.

A heap of mild lime produces on the spot white clover; a heap of hot lime couch-grass. The seeds of both are believed to have been latent, and all but those of couch-grass destroyed by the latter. White clover always vegetates in a calcareous soil.

CLOVE-TREE, a native of the Moluccas, whose inhabitants were scarcely acquainted with its value, till some Chinese vessels transported plants into China, and were thus the means of distributing them into India, Persia, and Arabia. The Molucca Isles were discovered by the Portuguese in 1511; and cloves came into common use in Europe. But the Dutch, after driving the Portuguese from the Spice Islands, strove to take the monopoly of all the spices into their own hands; and, for this purpose, after endeavouring to destroy the trees in the neighbouring islands, they concentrated their cultivation in Amboyna and a few small islands in the vicinity. A military officer, with European attendants, and 20 or 30 Buggness soldiers, are sent to the other islands annually, with axes, to destroy the clove-trees. They also reduced the quantity of bearing trees in their own possession to 500,000; which yielded, upon the average, a million of lbs. One of the largest sales ever made in Holland was (in 1714) 435,427 lbs., and, in 1738, 400,000 lbs.; whilst, in the Indies, about 150,000 lbs. or 200,000 lbs. were disposed of.

But the clove is now cultivated in numerous other countries. The French introduced it to their islands of Mauritius and Bourbon; and they have been found to succeed so well, that the tree which was first planted, in some years, produced 125 lbs. of this spice: whereas, the average produce in Amboyna is but 2 or 2½ lbs. per annum. It requires 5000 cloves to weigh a lb.; consequently, there were 625,000 flowers upon this single tree, independent of others, left for seed. It grows 40 feet high, throwing out innumerable branches, some of which, falling down on all sides, form a pyramid of verdure.

Plants were sent from the Mauritius to Cayenne about 1779; and, in 1792, the plantations there contained 2500 trees, which bore cloves which fetched a higher price in France than those from the Moluccas. Others were sent to Martinique, and the French islands; so that the former furnished the London market, in 1797, with 350 lbs. and in the following year with 200 lbs., and St. Kitt's sent 2981 lbs.

From Martinique it was introduced to St. Vincent's, and brought to perfection. About April the tree is covered with blossoms, the greater part of which prove abortive, and, falling to the ground, are collected, and dried for sale. The berries which remain on the tree gradually enlarge their calyx and develope the seed, which require to be set out immediately, and planted near the surface, as they vegetate rapidly. In St. Vincent's, the trees produce annually upwards of a million of seed, besides the abortive fruit, which is dried as a spice. In Trinidad, too, the clove is extensively cultivated.

The uses of cloves are well known. In medicine, they are esteemed tonic and exhilarating, powerfully stimulating on the muscular fibres, but injurious to bilious persons, and those of sanguine temperament. Their acrid and burning taste depends on the essential oil, which is procured by distillation, and is hot and caustic, and therefore employed in curing the tooth-ache and other maladies, and by perfumers. Its sp. gr. is 1·02.

The clove-tree lives 24 years, and bears from 6 to 20 years. In 1789 it was carried to the West Indies, and now flourishes there. 5 to 10 grains of the powder is used in dyspepsia with cold stomach.—*Curtis's Bot. Mag.*

CLYSTER. *See* ANEMA.

COALS, our modern fuel, are now agreed to be ancient forests, overthrown by irruptions of the sea, and covered by beds or strata of marine debris and deposits. The pressure and heat, in countless ages, has charred it, and we now use it as fuel, to fix oxygen and concentrate heat. Burnt in a close vessel it becomes coke, a substance denser than charcoal, the similar product of recent wood. There are three kinds, the product of different trees, or of different ages of the world. The black inflammable, the black uninflammable, and the brown. The former are those of Newcastle, Derbyshire, Yorkshire, and Staffordshire. The uninflammable are only so in less degree, as the Welsh and Kilkenny stone-coal. The brown are the Bovey, wood half charred, and of a species containing little bitumen.

The heat of equal weights of coal is 45, wood 26, coke 47, and charcoal 48. Peat from moss gives but 10; while hydrogen itself affords 185. So that coal, coke, and charcoal, are one-fourth.

Coals are distinguished by their quantity of hydrogen. Some have 30 per cent. of hydrogen, and burn vividly with much flame, as the Newcastle, Yorkshire, and Staffordshire; and others have not above 3 per cent., as Kilkenny and Welsh, which burn only with others, or in heated masses.

Flaming coals burn more or less clearly as the oxygen, or air, has more or less access to the mass. When part is on fire, and part not, the last gives out much smoke, or hydrogen and carbon, which form soot.

Flame is the combustion of parts of the smoke; and smoke, sufficiently heated, is flame. On this principle, the gas generated by heating coals in furnaces inflames with a light, and affords itself so fine a light. Fire is red-hot coal or wood; flame is the scattered particles of hydrogen and carbon, also red-hot. The heat, in both cases, arises from the fixation of atoms of oxygen gas, whose motion is destroyed by excited hydrogen; and parting with their motion at the surface of the combustible, where the hydrogen is evolved, they sustain the heat as long as hydrogen is evolved. A red heat, without flame, merely indicates that the hydrogen is not carried off by other volatile matter, but is combined with the oxygen as fast as evolved at the surface. On this account, coke is hotter than coal, and charcoal than wood, for there is less dispersion and cooling in the surrounding air.

Coal, the strata of ancient forests, consists essentially of carbonaceous matter, and, in one variety, the blind coal, this is nearly pure; but, in the varieties of coal, there is present a soft bituminous matter, which communicates to them peculiar properties. Those which contain much bitumen are highly inflammable, and burn with a bright flame; those in which carbon predominates burn less vividly. They may be treated of under two divisions, of *black coals* and *brown coals*. Brown possesses a ligneous structure, or consists of earthy particles; but black coal does not, in general, possess the structure of wood.

Some varieties of black coal resemble those of brown coal, as *pitch coal*, of a velvet-black colour, generally inclining to brown, strong lustre, and presenting, in every direction, a large and perfect conchoidal fracture; *slate coal*, possessing a more or less coarse slaty structure, which, however, seems to be rather a kind of lamellar composition than real fracture; *foliated coal*, resembling it, only the laminæ are thinner; and *coarse coal* in like manner, only the component particles are smaller, and approach to a granular appearance; *cannel coal*, without visible composition, and having a flat conchoidal fracture in every direction, with but little lustre, by which it is distinguished from pitch coal.

As the preceding varieties of coal consist of variable proportions of bitumen and carbon, they, of course, vary in their inflammability. Several varieties become soft, and others coke, when kindled, or, in other words, allow of the separation of the bituminous from the carbonaceous part. We perceive this separation in combustion in a common fire; the coal, when kindled, swelling and softening, exhaling a kind of bitumen, and burning with smoke and light; while, after a certain period, these appearances cease, and it burns only with a red light. The separation is effected more completely by the application of heat in close vessels: the bitumen is melted out, and there is disengaged ammonia, partly in the state of carbonate with empyreumatic oil, and *coal gas* (a variety of carburetted hydrogen,) often mixed with carbonic acid and sulphuretted hydrogen, the carbonaceous matter being, in a great measure, left, forming coke.

The decomposition of coal is carried on, on a large scale, with a view to collect the products; the gas being used to afford an artificial light, which is clear, steady, easily regulated, and economical. The bituminous matter, or mineral tar, is applied to the uses for which vegetable tar and pitch are employed; and the coked coal is used in the smelting of metallic ores, and for various other purposes, where a steady temperature is needed.

The varieties called *slate coal*, *foliated coal*, *coarse coal*, *cannel coal*, and *pitch coal*, occur chiefly in the coal formation; some varieties of pitch coal, also the moor coal, bituminous wood, and common brown coal, are met with in the formations above the chalk; the earthy coal, and some varieties of bituminous wood and common brown coal, are often included in diluvial and alluvial detritus. The coal seams alternate with beds of slaty clay and common clay, sandstone, limestone, sand, &c. They are often associated with vegetable organic remains, in slaty clay; sometimes, also, with shells, and having iron pyrites intermixed with them. Bituminous coal is so universally distributed, that it is unnecessary to attempt the enumeration of its localities. It abounds in England, and in the United States.

Coals, at least those of burning quality, are seldom found in mountainous districts, since rocks were not adapted to the growth of forests, whose falling and accumulations produced beds of coal. But districts favourable to forest growth, covered with the debris of tides, as clay, shingle, gravel, sandstone, shiver, &c. &c. are most likely to afford coal. To determine these, without boring, the out-crops of strata must be sought around, and these will shew the dip, thickness, nature, &c. of the strata. The springs, too, should be examined. There may be suspicion of coal when they deposit an ochreous sediment with iron flavour, for ironstone and coal usually accompany each other. Coal, however, gives a darker tinge, and it often happens that small bits of coal emerge with the water, and may be discovered around it. This water has passed through the ironstone to coal stratum, but, in other cases, a coal stratum may afford springs, not of ochreous colour, but characterized by unctuosity and astringency. When coals have been found in a neighbourhood, and a shaft sunk to *win* them, nothing is more easy, than by observing the dip and cropping of the strata in the pit, than to determine the direction and extent of the coal seam, in regard to any other place in the vicinity.

The average weight of coals is 75 lbs. to the cubic foot, which $\times$ 27 = 2023 lbs. or 18 cwt. Hence, a ton is about 28 cubic feet. If broken, the interstices swell it to above half more in bulk. When the seam is 2 feet thick it yields, clear of pillars, &c. 2400 tons per acre, when 3 feet 3700, and when 6 feet, 6000 tons.

In coal-pits there is the *broad* way of working, now in general use, which consists in clearing one division first, with wooden props, and letting it fall in; and the *narrow* way, which opens the whole seam, with pillars of support throughout. A furnace near the pit rarifies the air, and clears the mine of carbonic acid gas, which is aided by doors, so as to keep up a current throughout.

Inflammable hydrogen, still so destructive, may be rendered harmless by the safety-lamp, carefully managed, but explosions are rendered less generally destructive by Buddle's swinging doors, which, by yielding, allow any explosion to exhaust itself. Burning the gas, too, as it is generated, and borings through the roof, are often useful; especially if a tube at the top is lighted. Water, the great obstructor, is removed by any ordinary steam-engine, or by Brown's more simple carbonic oxide engine. In general, rich proprietors are too negligent of the comforts, conveniences, and lives of the labourers. Nine times in ten they or their overseers ought to be criminally prosecuted when accidents occur.

The mining of coals is, by no means, a matter of certain or great profit. The expences of sinking the shaft, of communications to the pit, of steam-engines, &c. are great, and render the results very precarious. The coal-owners at Newcastle get about 9*s*. a ton. In Yorkshire, they are sold at 4*s*. 6*d*. and 5*s*. In Derbyshire, Leicestershire, and Staffordshire, at 6*s*. and 7*s*. The cost of raising them is 3*s*. 6*d*. or 4*s*. per ton, after the shaft is open for working. Owing to freight and charges, Newcastle coals fetch from 25*s*. to 30*s*. in London, an enormous waste on above two millions of tons, or 10 lbs. per house. The trade is 7000 cargoes, making as many arrivals per annum, in about 1200 ships, at six voyages each per annum. The whole quantity of coals carried coast-wise, from all places, is nearly six millions tons per annum, and the total consumption is about 16 millions of tons, on the spot, by canal, coast-wise, &c. *i. e.* about 5 per house in Great Britain. Coals, therefore, are most important articles of the economy of life, in a country devoid of forests, like Great Britain. But, for the submerged and buried forests, the country would be comparatively uninhabitable.

The South Welsh Coal-basin affords not only numerous beds of common bituminous coal, but also beds of glance-coal, or anthracite; and the quantity of ironstone it contains is so vast, that nearly one-third of the immense supply of British iron is raised, smelted, and manufactured within its circumference. It is the source from which the Cornish mines derive their supply of coal, and is the market to which London must look for a supply, whenever that period arrives that the coal of our northern districts either becomes so scarce, or is so difficult and expensive to procure, that it cannot compete with that of Wales. The sides of the coal basin are of mountain-limestone, which rests upon the old red sandstone. The coal formation exhibits the usual rocks and alterations. In some places, the position of the strata seemed changed by some action after their deposition; in others, natural unaltered wavings of the strata occur. The quantity of carburetted hydrogen gas occurring in the Welsh collieries is very trifling, as compared with the Durham and Northumberland districts: this may, in some degree, arise from the greater inclination of the strata allowing the gas to find its way to the surface between the planes of the different beds; that it cannot be altogether attributed to the great inferiority of the Welsh coals, for the artificial production of gas is evident, from the remarkable fact, that the glance-coal (stone-coal) seams generally abound more in fire-damp than the seams of bituminous coal. In regard to the quantity of coal in the whole basin, Mr. Forster calculates, it is true, in a rough way, that it may amount to about 16,000 millions of tons. The annual quantity of coal consumed and exported from Wales, amounts, according to our author, to 2,754,895 tons.

About 15 millions of tons of coals are consumed in Great Britain per annum, or nearly a ton per inhabitant, of which four are raised in the Newcastle district. But it is computed that this district contains 837 squares miles, with thicknesses averaging 12 feet, of which but 105 have been excavated in 300 years; consequently, the 732 miles will last another 2000 years. The coal surface is, however, 20 times that of the Newcastle district, and in Wales the thickness 90 to 100 feet; hence there appear to be coals for many thousand years, at a consumption of a ton per inhabitant, even if science do not discover briefer means of generating heat, of which we seem at present on the verge. Coals are very abundant in the Netherlands and their French frontiers; also in North America.

*Caking-coal*, binding-coal, or crozzling-coal, as obtained in great abundance from the extensive coal-fields in Northumberland and Durham; is the kind which is sold in the London market as Newcastle coal. When heated, this coal breaks asunder into small pieces; and the heat being raised to a certain degree, the pieces cohere, and form a solid mass, from which property it is called caking-coal. It lights easily, and burns with a lively yellow flame. It requires to be frequently stirred or broken up, particularly when it cakes very hard; but different varieties differ considerably in this property. Of the Newcastle coals, the best Wall's End make a brilliant and pleasing fire, burn away quickly, and do not cake hard, hence it is preferred for heating rooms; but the Tanfield Moor burn slowly, cake very hard, and afford a strong and long-continued heat, and is used in furnaces and forges.

From the trials of Mr. Watt, it appears that a bushel of Newcastle coals, which weigh, on an average, 84 lbs. will convert from 8 to 12 cubic feet of water into steam, from the mean temperature of the atmosphere; and that a bushel of Swansea-coal will produce an equal effect. Black states that 7 lbs. ·91 of the best Newcastle coal will convert one cubic foot of water into steam, capable of supporting the mean pressure of the atmosphere. In other experiments, it appears that one cubic foot of water may be converted into steam, with 7·45 lbs. of coal, and, at a mean, with 8·15 lbs. Smeaton made it 11·4 lbs. to produce the same effect. After the brick-work, &c. of the boiler is warm, 1 lb. of Wall's End coals make a cubic foot of water boil.

*Splint-coal*, hard-coal, or slaty cannel-coal, is esteemed as valuable, for many purposes, as the Newcastle caking-coal. A greater heat is necessary to make it kindle than is required for caking-coal; and consequently it is not so well adapted for a small fire; but a large body of splint-coal makes a strong and lasting fire.

*Cherry-coal*, or soft-coal, constitutes the greater part of the upper seams in the Glasgow coal-fields; and Staffordshire coal is of the same species. It readily catches fire, and burns with a clear yellow flame, giving out much heat; and the flame continues till nearly the whole of the coal is consumed.

COAL BALLS, are made of 1 pounded Welsh coals and 2 of clay, dried and used to form the front of a fire intended to last during many hours.

COAST-LIGHTS.—Mr. Martin, the deservedly celebrated painter, details the particulars of a method invented by him, of guiding vessels by night as well as by day, through the shoals which beset the English coast, by means of suspended light-towers. Mr. Martin recommends, that after ascertaining, by boring, the depth of the sand, a broad triangular foundation shall be laid in the following manner:—The material of the foundation to be hollow metal boxes, each furnished at one end with two projecting portions, and at the other with two corresponding holes, so that each box may be firmly locked into that on either side of it; the boxes are hollow, that they may be more easily managed by the workmen, and are less expensive, but they will be sufficiently heavy, because each box, as it sinks, will be immediately filled with sand. One hollow triangular layer of these boxes, thus inseparably locked in each other, must, in the interval of one low tide, be deposited upon the sand. This layer will have sunk to a certain depth at the ebbing of the next tide, when another triangular layer of these boxes must be dropped upon the first. This additional weight would cause the first layer to sink still deeper. And over these, at a very low tide, fresh layers of boxes must be sunk, until the lowest has reached the firm sand, or other substance, and will sink no further. Into every hollow box, as it descended, the sand would enter: it would also completely fill the hollow triangular foundation, and being protected by it from any external influence, would add to its stability. When so many layers of boxes have been sunk, that the upper layer lies within three or four feet of the surface of the sand, and will not sink further, the foundation would be completed. A light-tower, circular in form, as that least likely to be affected by the influence of the winds and waves, about 10 feet in diameter, might then be suspended from the junction of three wrought-iron legs, inserted into the foundation, and strongly united at their apex, thus assuming the form of a pyramid, with an equilateral triangular base. But upon rocks lying beneath the water, the hanging tower could be adopted with greater advantage.—*See* LIGHT-HOUSES.

**COBALT** occurs alloyed with arsenic, nickel, and other metals, and mineralized by oxygen and by arsenic acid. It is obtained, after the ore has been roasted and calcined, in the state of an oxide, which is impure from the presence of other metallic oxides. When this oxide is obtained in a state of purity, and reduced to the metallic state, we are presented with a metal of a white colour, inclining to gray, and, if tarnished, to red, with a moderate lustre. Its fracture is compact; it is hard, brittle, and of a sp. gr. of 7·8. Like nickel, it is sensibly *magnetic*, and is susceptible of being rendered permanently so. It undergoes little change in the air, but absorbs oxygen, when heated in open vessels. It is attacked with difficulty by sulphuric or muriatic acid, but is readily oxidized by means of nitric acid.

There are but two oxides of cobalt: the protoxide of an ash-gray colour, and the basis of the salts of cobalt, most of which are of a pink hue; and, when heated to redness in open vessels, it absorbs oxygen, and is converted into the *peroxide*. It may be prepared by decomposing the carbonate of cobalt by heat, in a vessel from which the atmospheric air is excluded. It is known by giving a blue tint to borax, when melted with it, and is employed in the arts, in the form of smalts, for communicating a similar colour to glass, to earthenware, and to porcelain.

*Smalts*, or powder-blue, is made by melting three parts of fine white sand, or calcined flints, with two of purified pearl-ash and one of cobalt ore, previously calcined, and lading it out of the pots into a vessel of cold water; after which, the dark-blue glass, or zaffre, is ground, washed over, and distributed into different shades of colours, which shades are occasioned by the different qualities of the ore, and the coarser and finer grinding of the powder. Smalts, besides being used to stain glass and pottery, are often substituted, in painting, for ultra-marine blue, and is likewise employed to give to paper and linen a bluish tinge. The muriate of cobalt is the celebrated *sympathetic ink*. When diluted with water, so as to form a pale pink solution, and then employed as ink, the letters which are invisible in the cold become blue, if gently heated.

One grain of oxide of cobalt gives a full blue to 240 grains of glass.

Pulverized cobalt, strongly heated, takes fire. The combustion is at first slow, and not perceived till the end of two or three days: the mass is then very hot and luminous, if ever so little stirred. It was covered and set to cool. 20 lbs. of it were packed up; but, on the following night, the package set fire to the objects with which it was interlaid, and afterwards to the warehouse.

Cobalt is prepared from cobalt glame. It is a reddish grey, with 8·7 sp. gr. When purified, it absorbs oxygen and forms two oxides.

*Cobalt black*, or *Oxide of Cobalt*, is made by boiling powdered bright-white cobalt ore, found in Cornwall, in nitric acid; diluting with a large quantity of water; adding subcarbonate of potash water, in small successive portions, and letting the solution settle; then decant off the clear each time until it becomes of a rose-colour; add subcarbonate of potash water as long as any sediment falls, which wash and dry. It is used to make blue colors.

*Cobalt blue* is made by washing of two parts of zaffre, and pouring on it one part of nitric acid, diluted with equal water. Digest for some hours, and add fresh acid as long as it extracts any color. Mix the colored solutions, and evaporate nearly to dryness, then dissolve in warm water, and filter the liquor, adding to the filtered nitric solution of the zaffre a solution of phosphate of soda as long as sediment falls. Wash this, and mix it with eight times as much alumine, fresh precipitated by sufficient liquid ammonia. Stir till the color is quite uniform, then dry it, and heat it cherry-red in a crucible.

COCCULUS INDICUS, *(Menispermum)* has capsules so acrid as to intoxicate fish, and destroy vermin. It is, therefore, used by brewers, to give false strength to beer. It is retailed at 5*s*. 6*d*. the lb. but a lb. goes as far as a sack of malt. The fault is in the legislature, and while a man may be transported for stealing to the value of a shilling, these destroyers of the public health escape and get rich.

COCO, or Cocos, a Brazilian palm, where it is called the Mackaw-tree. It grows high, and yields fruit all the year. This fruit has a yellow skin and pulp, within which is a nut like the cocoa-nut, which yields oil by mashing in hot water. This is the semi-fluid-oil, brought from Brazil, of which such fragrant candles are now made, called cocoa-nut; but far more of it is brought from Guinea, where it is produced from another variety of palm, called the elais, which yields still more oil, the imports of which have quintupled in the last four or five years, since it is found that it makes better candles than any other material, and is likely to be at a lower price than noisome tallow, as the imports and competition increase. In families in London they are in general use, though dearer than tallow.

COCOA-NUT, a woody fruit, of an oval shape, from three or four to six or eight inches in length, covered with a fibrous husk, and lined internally with a white, firm, and fleshy kernel. The tree *(cocos nucifera,)* is a species of palm, from 40 to 60 feet high, having only on its summit leaves or branches, which appear like immense feathers, 14 or 15 feet long, 3 feet broad and winged. The upper ones are erect, the middle ones horizontal, and the lower ones drooping. The trunk is straight, naked, and marked with scars of the fallen leaves.

The nuts hang from the summit of the tree, in clusters of a dozen or more The external rind has a smooth surface, and is of a triangular shape. This encloses an extremely fibrous substance, of considerable thickness, which immediately surrounds the nut. The latter has a thick and hard shell, with three holes at the base, each closed with a black membrane. The kernel, which lines the shell, is sometimes nearly an inch thick, and encloses a considerable quantity of sweet and watery liquid, of a whitish colour, called *milk*.

The tree is a native of Africa, the East and West Indies, and South America, and flourishes best in a sandy soil. Food, clothing, and the means of shelter and protection are afforded by it. The kernels, which somewhat resemble the filbert in taste, but of much firmer consistence, are used as food in various modes of dressing, and sometimes are cut into pieces and dried. When pressed in a mill, they yield oil, which, in some countries, is the only oil used at table; and which, when fresh, is equal in quality to that of almonds. It, however, soon becomes rancid, and, in this state, is principally used by painters. The milk or fluid contained in the nut is an exceedingly cool and agreeable beverage, and, when good, resembles the kernel in flavour.

Cocoa-nut-trees first produce fruit when six or seven years old; after which, each tree yields from 50 to 100 nuts annually. The fibrous coats, or husks, which envelope the cocoa-nuts, after having been soaked for some time in water, become soft. They are then beaten, to free them from the other substances with which they are intermixed, and which fall away like sawdust, the stringy part only being left. This is spun into long yarns, woven into sail-cloth, and twisted into cables, even for large vessels. The cordage thus manufactured is, in several respects, preferable to that brought from Europe, but particularly for the advantages which are derived from its floating in water.

The woody shells of the nut are so hard as to receive a high polish, and are formed into drinking-cups, and other domestic utensils, which are sometimes expensively mounted in silver.

On the summit of the cocoa-nut-tree, the tender leaves, at their first springing up, are folded over each other, so as somewhat to resemble a cabbage. These are occasionally eaten in place of culinary greens, and are a very delicious food; but, they can only be obtained by the destruction of the tree, which dies, in consequence of their being removed. The larger leaves are used for the thatching of buildings, and are wrought into baskets, brooms, mats, sacks, hammocks, and many other articles.

The trunks are made into boats, and furnish timber for the construction of houses; and, when their central pith is cleared away, they form excellent gutters for the conveyance of water. If, whilst growing, the body of the tree be bored, a white and sweetish liquor exudes from the wound, which is called *toddy*. This is collected in vessels of earthenware, and is a favourite beverage where the trees grow. When fresh, it is very sweet; in a few hours, it becomes somewhat acid, and, in this state, is peculiarly agreeable.

COFFEE, is a pleasant, wholesome, and cheap beverage, made from the roasted and bruised grain of a tree, which alone grow in Arabia Felix. But, about 1690, the Dutch planted some of the seeds at Batavia, whence it was carried to the West Indies; so that 40 million lbs. are now imported into the United Kingdom, and about 20 consumed at home. Of the whole, about a sixth is brought from the East, and perhaps not a sixth of this from Arabia. The entire production is full 250 millions of lbs.

Coffee is the seed of an evergreen shrub, from 15 to 20 feet high. The leaves are four or five inches long, and two broad, smooth, green, glossy on the upper surface; and the flowers, which grow in bunches, are white and sweet-scented. The berries and fruit are of an oval shape, about the size of a cherry, and of a dark-red colour, when ripe. Each contains two cells, and each cell a single seed, which is the coffee as we see it before roasted. Coffee is an article of but recent introduction, and the coffee-shrub was first planted in Jamaica in 1732. In Arabia, the trees are raised from seed sown in nurseries, and afterwards planted out in moist and shady situations, on sloping grounds, or at the foot of mountains. Care is taken to conduct little rills of water to the roots of the trees, which, at certain seasons, require to be constantly surrounded with moisture. As soon as the fruit is nearly ripe, the water is turned off, lest the fruit should be rendered too succulent. In places much exposed to the south, the trees are planted in rows, and are shaded from the otherwise too intense heat of the sun, by a branching kind of poplar-tree. When the fruit has attained its maturity, cloths are placed under the trees, and upon these the labourers shake it down. They afterwards spread the berries on mats, and expose them to the sun to dry. The husk is then broken off by large and heavy rollers of wood or iron. When the coffee has been thus cleared of its husk, it is again dried in the sun, and, lastly, winnowed with a large fan, for the purpose of clearing it from the pieces of husks with which it is intermingled. A lb. of coffee is generally more than the produce of one tree; but a tree in great vigour will produce 3 or 4 lbs. The best is imported from Mocha; and this kind, which is denominated Mocha and Turkey coffee, is of a better quality than any which the European colonists are able to raise, owing, as it is supposed, to the difference of climate and soil in which it grows. It is packed in large bales, each containing a number of smaller bales, and, when good, appears fresh, and of a greenish-olive colour. The coffee next in esteem to this is raised in Java, and that of lowest price in the West Indies and Brazil. The quantity of coffee annually supplied by Arabia is supposed to be upwards of 14,000,000 lbs.

All Mohammedans drink coffee, at least twice a day, very hot, and without sugar. The excellence depends, in a great measure, on the skill and attention in roasting. If too little roasted, it is devoid of flavour, and if too much, it becomes acrid, and has a burnt taste. It is usually roasted in a cylindrical tin box, perforated with numerous holes, and fixed upon a spit, which runs lengthwise through the centre, and is turned by a jack or by the hand.

Coffee, as commonly prepared by persons unacquainted with its nature, is a decoction, and is boiled for some time, under a mistaken notion that the strength is not extracted unless it be boiled. But the fact is the reverse. The fine aromatic oil, which produces the flavour and strength of coffee, is dispelled and lost by boiling, and a mucilage is extracted at the same time, which makes it flat and weak. The best modes are, to pour boiling water through the coffee in a biggin or strainer, which is found to extract nearly all the strength; or to pour boiling water upon it, and set it upon the fire, not to exceed 10 minutes. As a medicine, strong coffee is a powerful stimulant and cordial, and, in paroxisms of the asthma, is one of the best remedies; but it should be very strong, and made with almost as much coffee as water. In faintness, or exhaustion from labour and fatigue, and from sickness, coffee is one of the most cordial restoratives. There are coffee-machines, in which the water is boiled, and the steam penetrates the coffee, and extracts, to a great degree, the fine aroma. Immediately after, boiling water is poured over it, and thus the best coffee is made.

In Europe, coffee is generally roasted in a cylinder; but, in Asia, open pans or tin plates are used, and, if the time allows, a boy is employed, who picks out every bean, when it has reached the right degree of brownness. The second difference in the Asiatic way of preparing coffee is, that they pound the beans, and do not grind them. Asiatic coffee is, on the whole, much better than the European, and the difference is probably owing to the different roasting, &c.

The Turks and Arabs boil each cup by itself, and only for a moment. They do not separate the coffee from the infusion, but leave the whole in the cup, and it improves the beverage very much to roast and grind the coffee just before it is used. The Turks drink coffee at all times of day, and present it to visitors both in the forenoon and afternoon, and the opium-eaters live almost entirely on coffee and opium. Beaujour tells of an opium-eater, who drank more than 60 cups of coffee in a day, and smoked as many pipes. Coffee has been the favourite beverage of many distinguished men.

The best coffee in the western world is made in France, where it is in universal request. In fact, throughout the continent of Europe, it is generally drank. In England, coffee is almost always badly made. In the East, the coffee-houses, or rather booths, form a very essential part of the social system; all men of leisure assembling there. In these places are also to be found the famous story-tellers, who repeat long tales to attentive hearers, who show their interest by exclamations of "God save him!" "Allah deprive him of his eyes!" &c., or utter warning cries, to alarm the hero when danger awaits him. It often happens, that the story is broken off, and continued the next day.

In Egypt, the drinking of coffee seems to have been at first regarded almost as a religious ceremony. The devotees, who introduced it there, assembled for the purpose of enjoying it on Monday and Friday evenings, when it was handed round with great solemnity, accompanied with many prayers, and with exclamations of "There is no God but God!" There are also two different methods of making coffee, one called *buniyya*, in which the grain and husk are used together, and another, called *kishariyya*, in which the husk is used alone.

A dry air and sandy soil best suits coffee; hence the Mocha is still the best, and 50 per cent. in price above any other. The Jamaica and Demerara are the next in quality. The roasting is a very delicate operation, as it is heavy if underdone, and very astringent if overdone. So the mill should not reduce it to powder, only equally break it; it should not be stewed, only scalded. Several kinds of grain, treated in like manner, make a coarse imitation of coffee, as acorns, beans, wheat, barley, &c.

The usual allowance for coffee in England is about one quarter of an oz. for each person; the Dutch and Germans allow about three times as much. It was formerly boiled up several times, whole black mustard-seed added, to increase its stimulant quality, and then clarified with an egg. At present, it is a mere infusion, the hot water being only run through it, and the infusion heated again.

Late experiments have shewn that the best way of making coffee is, to put the ground coffee into a wide-mouthed bottle over-night, and pour rather more than half a pint of water upon each ounce and a half; to cork the bottle; in the morning to loosen the cork, put the bottle into a pan of water, and bring the water to a boiling heat; the coffee is then to be poured off clear, and the latter portion strained; that which is not drank immediately is kept closely stopped, and heated as it is wanted.

Rye, roasted with a little butter, is much used in England as coffee, by the name of *Hunt's Breakfast-powder*. On the Continent, about a third of succory-root roasted is added, to diminish the expense of drinking pure coffee.

The coffee should be roasted only till it is of a cinnamon-colour, and closely covered up during roasting. In France, this is done in closed iron cylinders, turned over a fire by a handle, like a grindstone. The coffee should be *coarsely* ground soon after it is roasted, and quite cool. Its aroma is better preserved by beating in a mortar. The proportions are usually one pint of boiling water to two ounces of coffee. The coffee being put into the water, the coffee-pot should be covered up, and left for two hours, surrounded with hot cinders, so as to keep up the temperature, without making the liquor boil. Occasionally stir it, and after two hours' infusion, remove it from the fire, and allow it a quarter of an hour to settle, and when perfectly clear, decant it. Isinglass, or hartshorn-shavings, destroy its aroma.

In England, coffee is generally over-roasted, and from this fault arise all the inconveniencies which are so often attributed to coffee, but which, in reality, are produced by imperfect modes of its preparation.

The seeds of foreign grapes have been discovered to be an excellent substitute for coffee. When pressed they produce oil, and afterwards, when boiled, furnish a liquid very similar to that produced from coffee.

Dandelion coffee is as good as that of

Mecca. Dig up the roots of dandelion, wash them well, but do not scrape them, dry them, cut them into the size of peas, and then roast them in an earthen pot, or coffee-roaster of any kind. The great secret of good coffee is, to have it fresh burnt and fresh ground.

COFFEES, IMITATION. *Corsican*, made from the seeds of knee-holly, *Ruscus aculeatus*.—*Rosetta coffee*, from the seeds of *fenugreek*, adding a little lemon-juice.—*Egyptian coffee*, from *chich peas*.—*Holly coffee*, from the berries.—*Broom coffee*, from the seeds.—*Gooseberry coffee*, from the seeds washed out of the cake left in making gooseberry-wine.—*Currant coffee*, from the seeds washed out of the cake left in making currant-wine.—*Rice coffee*, from the husked seeds: this is esteemed the best substitute in India, where it is sometimes found that this substitute agrees better than the Turkey coffee.—*Rye coffee*. Rye roasted along with a little butter, and used as coffee. It is a good substitute, and can scarcely be distinguished from it. —*Succory coffee* is succory root roasted with a little butter or oil; but it wants the aroma.—*Iris coffee* is the seeds of the yellow water-flag, and is the best of the European substitutes.

COFFINS, were used by the ancients only to receive the bodies of persons of the highest distinction. At the present time, they are not used in the East, either by Mohammedans or Christians; and the Jews do not use coffins, but only two boards, between which the corpse is tied. Coffins, among Christians, were probably introduced with the custom of burying. It has been often proposed that they should be made with a hole opposite the place of the mouth of the body, so as to allow breathing, in case of revival. Of course, it would be necessary, at the same time, to let the coffin stand for some days in a convenient place, as is the custom in Germany.

COGS OF WHEELS, are called *teeth*, in wheels; *leaves*, on pinions or axles; and *spindles*, on hollow lanterns. Their forms should be Epicycloidal.

COHESION, is the passive relative force with which the particles of bodies unite, and it arises from their mutual fitness, their smallness, their own atmospheres, and the atmosphere in which they usually exist. As they become smaller, more parts fit in relation to the resulting mass, and they form fibres or chains, and irregular small masses, which dove-tail with the other masses. The first union in grains is effected by aerial or gaseous pressure, or if in crystals, it is the pressure of the atmosphere, since crystals are not formed in vacuo. When atoms, or particles of compound atoms are thus united, the edges of the finest tools are too broad and blunt to penetrate them; and to break, separate, and pulverize them, we must have recourse to sharp percussions, which shake them asunder; or to heat, which vibrates every atom by its motion; or to fluids already in motion. Sometimes, both heat and percussion are necessary.

M'Adam, in breaking his stones for roads, acquires a maximum cohesion by multiplying their fitting surfaces. All bodies, too, have atmospheres, as appears by their effect on light, and by similar bodies uniting better than dissimilar ones, and the action of the general atmosphere on the local ones often gives the appearance of preferences and aversions which in most unphilosophical language are called attractions and repulsions, or affinities. But, as neither atom nor body can push another atom or body towards itself, the cause must be sought in the common sense of ordinary mechanical action. By long external pressure, the fine sand of the sea-shores becomes stone, varied by clay, pulverized shells, &c. into different kinds of hard rocks. As the forms of the primitive or first atoms vary, so the body is as it were built up, and in dissolutions we often see the layers removed like blocks of stone, as in dissolving alum, &c. When forms are unfitting they break up easily, and the insinuation of unfit forms into a mass of fitting forms, often decomposes the whole.

Cohesion, in other words, relative *non-expansion*, is that state of atoms in which they are relatively at rest, or without respective atomic motion. It is itself an effect of no power, but the mere absence of those motions which create fluids and gases.

As no body exists independently of all other matter, and as atoms of like kind have similarly-crystallized sides, so the elastic pressure of other matter unites similar planes and creates solids; hence the pressure, and elastic pressure of air is essential to the formation of crystals. The apparent cement arises from the atmospheres of atoms, or from other intervening fitting atoms of less bulk. Structures are broken up simply when motion is so applied as to reach the several united atoms. One motion is that of heat, atomic in its origin and progress, and diffusing itself from atom to atom, putting each in motion, and separating it from those in juxta-position. Another motion is that of gross impulse, when a solid structure is laid on a fixed basis, as on a smith's anvil, so that action and reaction in the mass sometimes reduces the whole to powder, or breaks it into many pieces. The destruction of cohesion by motion is proof, therefore, that the cohesion was merely the effect of relative rest, and depends on no occult or magical powers of attraction or repulsion, powers which in their alleged mode of action are mechanical absurdities, and physical impossibilities. Certain degrees of the atomic motion called heat, reducing granular bodies to powder and crystallized to fluidity. A higher degree of the same motion, which becomes accelerated, renders one red hot, and so disperses the atoms of the other as to overcome the elastic pressure of the air, and, by projectile force and aerial reaction, convert them into gases.

In different bodies, it is exerted with different degrees of strength, and it is measured by the force necessary to pull them asunder. The *relative* cohesive strength of the metals is as follows:

| | |
|---|---|
| Gold | 150,955 |
| Silver | 190,771 |
| Platina | 262,361 |
| Copper | 304,696 |
| Soft iron | 362,927 |
| Hard iron | 559,880 |

Emerson calculates that the following bodies will carry the weights annexed, multiplied by the squares of the diameters of their cylinder in inches:—

| | |
|---|---|
| Iron | 135 cwt. by $d^2$. |
| Rope | 22 cwt. by $d^2$. |
| Oak | 14 cwt. by $d^2$. |
| Fir | 9 cwt. by $d^2$. |

Barlow makes Box, per square inch, 20,000 lbs.

| | |
|---|---|
| Ash | 17,000 |
| Fir | 12,000 |
| Oak | 10,000 |
| Mahogany | 8,000 |

Plate-glass being 1·00, and 9420, a constant multiplier for strength in lbs. one square inch locust-tree, is 2·621; ash, 1·274; oak, 1·86 to 1·00; teak, 1·4; elm, 1·432; dry willow, ·809; beech, 1·88; Riga fir, ·963; Scotch fir, ·711; white deal, 0·455; cedar, 0·528; steel razor, 15·927; iron-wire, 12; English cast-iron, 5·52; copper-wire, 6·6; gold-wire, 3·279; lead-wire, 0·334; tin-wire, 0·7568; platinum-wire, 6·00; silver, 4·09; hemp fibres, 9·766; ivory, 1·765; Portland stone, 0·083; brick, 0·03; plaster of Paris, 0·0054.

Cohesion in liquids is weak; and, in substances in the aerial form, it is entirely overcome by the motion of the atoms. It is weakened or overcome by two general causes—by the motion of atoms, called *heat*, as imparted by percussion, or by contact with heating bodies, or bodies affected by heat. Heat communicated to a solid body separates its particles to greater distances, as is evident from the enlargement of volume which it produces. By thus increasing the distances, the force with which aggregation or cohesion is exerted is diminished; if the heat be carried to a sufficient extent, the cohesion is so far weakened, that the body passes into the liquid form; and, if carried still farther, the force is entirely overcome, distance is established between the particles, and the body passes into the aeriform state.

COIN, is merely a symbol of value, stamped as such by authority. If gold, silver, or copper, it is also worth its weight of metal for manufacturing purposes, and therefore preferred to the stamp of authority on any other material. Anciently payments were made by weighing the metals, and to save trouble the common weights were marked on the metals by authority, and hence kings' heads on coins. But, in time, kings cheated their subjects, and marked pieces of smaller weight with the mark of the full weight. Thus our pound was, in 1300, a full pound of silver, and a shilling the 20th, but now 66*s*. are given for a pound, instead of 20 pieces of above treble the weight. By making coins of metals, rulers are restrained in issues, and a steady circulation is maintained, otherwise paper, duly stamped, answers every purpose of society, and is really more convenient and less expensive. But fluctuations in amount are ruinous to credit and industry, as was the case after the panic in England, when paper-money being discredited, no previous obligations could be met in gold, and general ruin fell on all classes, especially on the commercial. If paper could be restrained in amount, and issued on recorded security, it is, nevertheless, the best currency.

The British gold sovereign weighs 5 dwts. 3¼ grs. The gold Napoleon weighs 4 dwts. 3⅐ grs. The pure gold in the former is 113·1 grains, and in the latter but 89·7 grains. So that the Napoleon in gold is equal to 190⅓ pence English, and a franc in gold, the 20th, is 9·526 pence.

The British shilling weighs 3 dwts. 15¼ grs. and contains 80·7 grs. of pure silver, 1 lb. being 66 shillings. The French franc weighs 3 dwts. 5½ grs., and contains 69·4 of pure silver, so that a franc is in silver 10 pence and 1·28 farthing.

English copper coin is 72 per cent. above the value of the metal by weight.

From 1600 to 1816, the lb. of silver was divided into 62*s*., but since into 66*s*., the 4*s*. being a tax on the coinage.

The American dollar contains 370·1 grs. of fine silver, and is to our shilling as 4·586 to 1, or 4*s*. 7*d*. sterling silver for silver. It is usually called 4*s*. 3½*d*. or 4*s*. 4*d*.

COINAGE, is completed by one blow of the coining-press, and these presses are worked in the Royal Mint by machinery, so contrived that they strike, upon an average, 60 blows in a minute. The blank, previously prepared and annealed, is placed between the dies by part of the same mechanism. The number of pieces which may be struck by a single die of good steel, properly hardened and duly tempered, not unfrequently amounts at the Mint to between 3 and 400,000, but the average consumption of dies is, of course, much greater, owing to the different qualities of steel, and to the casualties to which the dies are liable.

There are eight presses at the Mint, at work for ten hours each day, and the destruction of eight pair of dies per day (one pair for each press,) is a fair average. Each press produces 3,600 pieces per hour, but, making allowance for occasional stoppages, the daily produce of each press is 30,000 pieces; the eight presses therefore will furnish a diurnal average of 240,000 pieces.

COIR, is the name of the very firm and durable cordage made of the fibres of cocoa-nuts. It is in general use in the East, and has been preferred to hemp by many navigators.

COKE, is the charcoal of coal, of which different kinds, and different treatment yields from 58 to 75 per cent. Its heat to that of coal is as 47 to 45, and the volatile parts being drawn off by the charring, it yields no smoke or soot; and is therefore preferred to coal in many manufactories and processes, as in iron smelting, &c. &c. It is the solid product or residuum of the gas-light manufactories.

Coke is made by raising a stack of many tons of coal, piled hollow in the lower parts, to permit the air and fire to penetrate and smother for some days through the mass. By this wasteful process, a ton of 2240 lbs. of coals are reduced to less than 1000 of coke, by the dissipation of the volatile parts. Newcastle coals are 58 coke, and 40 bitumen, sp. gr. 1·271. Staffordshire, 63 coke; Welsh, 73 coke. Dundonald effected what the Gas Companies effect in making the useful product of gas. He burnt the coals in stoves, and collected the bitumen in a chamber as tar, at the average rate of 1 ton for 25 of coals. This he evaporated into pitch, in bulk as 3-4ths of the tar, making at the same time the liquid varnish known as Dundonald's tar. Like the gas-works, he also collected ammonia. Coke may be considered as charred coal, though we call charred wood charcoal. Kilkenny coals afford 94 coke, being the heaviest coals, sp. gr. 1·6. Tenby coal, 90 coke, sp. gr. 1·368.

Staffordshire coke, as free from sulphur, earth, and metal, burns best in furnaces. The gas coke is full of oxide of iron, and earthy matter. Charcoal burns too quick, but charcoal and coke mixed answer well.

COLCHICUM, meadow saffron, the bulb of which, from June to August, yields an acrid white juice, whose alkaline proximate principle is called *veratrine*. As a medicine it is diuretic, purgative, and narcotic. It operates peculiarly on the gall duct, so as to increase the discharge of bile. In gout and rheumatic gout it is a very important remedy, and since this discovery by Mr. John Want, it has been used on the continent for dropsy and asthma. The dose is 3 grs. to 9 of the bulb, and of a vinous infusion from half to 1 fluid drachm, but it is a potent medicine and its flowers poison sheep and oxen. To preserve the bulb, it is cut into very thin slices, and dried on paper slowly.

COLD, is the absence of a certain degree of heat, or atomic excitement, or motion, and of course a condensor and fixer of atoms by negation of action, which superstition calls attraction, when a body passes from heat to cold; and repulsion when from cold to heat, though both are mere varieties of motion.

Great heat and its increase is not the only agent employed in chemistry, for its decrease or relative cold is useful in some operations. Certain operations can, therefore, only be performed successfully in winter; and although time alone will give a certain mellowness to vinous and spirituous liquors, yet variations of heat have great effect. The fine flavours of *Eau de Cologne*, and *Eau de melisse des Carmes*, arise from their being kept in an ice-house, or cold cellar.

The solution of salts in water expands it, and taking heat or motion from surrounding bodies, causes a cold diffusion. In fact, the conversion of the salt into fluid, is an abstraction of atomic motion from adjacent bodies. Equal parts of nitre and sal ammoniac added dry, added to three parts by weight of water, by their solution sink the thermometer 40°. So with salt and nitrate of potash. And more so, two parts nitrate of potash, three of Glauber's salts. And 57° is produced by nitrate of ammonia and carbonate of soda, in half water. If weak nitric acid is used as the solvent, instead of water, three times the phosphate of soda and two of nitrate of ammonia give 71°.

Rapid evaporation produces great cold, because the evaporation is produced by the transfer of motion. On this are founded hundreds of cooling processes, from a man wetting his finger and holding it up in the wind to the crystallizing of salt by throwing brine among faggots. The Moorish alcarrazos, or porous cooling jars, are another example.

But, the most rapid method is to place water under the approximate vacuum of an air-pump. We thus remove the elastic pressure which retained it in its fluid state as water, and it evaporates till the aqueous steam reacts. If then an absorbent powder, or a saucer of sulphuric acid is placed very near, so as to absorb the steam, other steam then rises till the remaining water, parting with the motion that makes the steam, is cooled down to a cake of ice. Nothing can be more simple in principle, or easy in practice, and this is Leslie's experiment. The acid is in force till it has congealed twenty times its weight of water. Parched oatmeal, or powdered whinstone, are nearly as efficient as sulphuric acid, and by redrying they serve many times.

Then, since sulphuric acid, or any absorbent, keeps the air dry and promotes the evaporation of water, it is found that if water be put in a porous evaporating pan, and placed in a close vessel over sulphuric acid, this so promotes evaporation and the radiation of heat, that in a few hours the water is cooled down from 20° to 30°.

The experiment is cheap, because heat will again and again restore the sulphuric acid to its first strength, and it should be noted that the acid warms as it absorbs, the whole being a transfer of atomic motion or heat.

Water boiled is more readily frozen, because it has already parted with the air, which always departs before it crystallizes. It would almost seem that water is in fact its ice, as a solid rendered fluid by distribution in air. If we had lived on a globe below 32°, we should have ranked water as one of the solids.

Nitre and snow, or salt and snow, produce great cold and freeze water. They melt the snow, and abstract heat from water in a vessel in contact. Of course, pounded ice is the same.

One part of purified salt and two of snow, or pulverized ice, produce cold 5° below zero. And 25° if instead of all salt half be nitrate of ammonia and 2½ snow. Whatever demands from the vicinity motion to dissolve the snow causes equal cold around. Four parts of caustic potash and three of snow produce cold 50° below zero. Then, by repeating the process, and with cautions which experience will suggest, a cold of 91° has been produced.

The cooling effect of the evaporation of ether, spirits, and sulphuret of carbon, is well known, and it arises from their boiling at a low heat.

Crystallized water, or ice, is kept in cellars at depths according to the climate. These cellars are without windows, surrounded by very thick walls. Precautions are taken to carry off any water which may arise from a partial thaw, by forming gutters across the floor, leading to a cesspool in the passage, whence the water can be taken out without opening the door. Where the surrounding soil is moist, a framework or cage of carpentry, grated at bottom, is constructed in the cellar, so as to be from one to two feet distant from the floor, sides, and roof.

Ice is also kept in the cellars of the confectioners in large cities, and also by some of the market-gardeners in heaps, built on an elevated base in the open garden, with no sort of building or frame-work whatever, but merely with a very thick covering of straw or reeds.

Ice-houses are generally like an inverted cone, or hen's egg, with the broad end at top. A dry spot should be chosen, since wherever there is moisture the ice will dissolve. The form may vary according to circumstances; but, for the well in which the ice is put, it is best to have sufficient room, as, when well built, it will keep the ice two or three years.

Where the quantity wanted is not great, a well of six feet diameter, and eight feet deep, will be large enough; but, for a large consumption, it should not be less than nine or ten feet diameter, and as many deep. Where the situation is dry, the pit may be below the surface; but in moist ground, it will be better to raise it above the surface.

At the bottom of the well there should be a space about two feet deep, left for receiving any moisture which may drain from the ice, and a small underground drain should be laid from this. The sides of the well must be walled up with brick or stone at least two feet thick; as the thicker the walls are made the less danger there is of the well being effected by external causes. When the wall of the well is brought within three feet of the surface, there must be another outer arch or wall begun, which must be carried up to the height of the top of the intended arch of the well; and if there be a second arch turned over from this, it will add to the perfection of the house. When covered with slate or tiles, there should be a thickness of reeds, straw, or other non-conducting materials laid under, to guard against the sun and external air, two feet thick, and plastered with lime and hair.

The door should be no larger than is absolutely necessary for coming at the ice, and must be strong and close to exclude the air; and, at five or six feet distance from this, another door should be contrived, which should be closely shut before the inner door is opened, whenever ice is taken out.

In the choice of ice, the thinner it is the better, as the smaller it is broken the better it will unite when put into the well. It should be rammed close, and a space left between it and the wall of the well, by straw being placed for the purpose, so as to give passage to any moisture. If snow is collected instead of ice, it should be pressed firmly together. To aid in consolidating, a little water may be occasionally applied from a watering-pot. An iron crow is necessary to take it up.

Cobbett says, an ice-house should not be under-ground, nor be shaded by trees, but be exposed to the sun and air; and that its bed should be three feet above the level of the ground, and composed of something that will admit of the drippings flowing instantly off. With some poles and straw the Virginians construct an ice-house for ten dollars, worth a dozen of those which cost in England 2 or 300*l*. They are double tall conical sheds, the walls and roof of which are of thatch, about a foot thick. The ice or snow is deposited in the inner shed, on a bed of straw, and the outer shed is so much larger and higher as to allow a person to go between them.

Cavallo relates some experiments for ascertaining the cold that was produced by causing certain liquids to fall upon the bulb of a thermometer, the atmosphere being 64°.

Water reduced the thermometer, in two minutes, to 56°; and then the production of cold ceased.

Spirit of wine to 48°.

Spirit of turpentine to 61°.

Olive-oil, and others that evaporate slowly, did not sensibly affect the thermometer.

Ether reduced the thermometer to 3°, or 29° below freezing, and with a small bulb only twenty drops of ether, and two minutes were required to produce this effect.

Half an ounce of good ether will freeze a quarter of an ounce of water, contained in a glass tube.

A very low degree of cold may be produced by mixing together different solids, which suddenly become liquid, and thus require a supply of heat or motion from the surrounding substances to make them cold.

Five of sal-ammoniac, five of saltpetre, and sixteen of water, sink the thermometer from 50° to 10°.

Five of sal-ammoniac, five of saltpetre, eight of Glauber's salt, and sixteen of water, from 50° to 4°.

One of nitrate of ammonia, and one of water, from 50° to 4°.

One of nitrate of ammonia, one of carbonate of soda, and one of water, from 50° to zero 25°.

Three of Glauber's salt, with two of diluted nitric acid, from 50° to 29°.

Six of Glauber's salt, four of sal-ammoniac, two of saltpetre, and four of diluted nitric acid, from 50° to 22°.

Six of Glauber's salt, five of nitrate of ammonia, and four of diluted nitric acid, from 50° to 18°.

Nine of phosphate of soda, with four of diluted nitric acid, from 50° to 11°.

Nine of phosphate of soda, six of nitrate of ammonia, and four of diluted nitric acid, from 50° to 11°.

Eight of Glauber's salt with five of muriatic acid, from 50° to 32°.

Five of Glauber's salt with four of diluted sulphuric acid, from 50° to 29°.

Five of phosphate of soda, three of nitrate of ammonia, and four of diluted nitric acid, from zero to 34° below zero.

Three of phosphate of soda, two of nitrate of ammonia, and four of diluted mixed acids, from 34° below zero to 50°.

Two of snow, or pounded ice, with one of common salt, from any temperature to 27°.

Five of snow, or pounded ice, two of common salt, and one of sal ammoniac, from any temperature to 20°.

Twenty-four of snow, or pounded ice, ten of common salt, five of sal-ammoniac, and five of saltpetre, to 14°.

Twelve of snow, or pounded ice, five of common salt, and five of nitrate of ammonia, from any temperature to 70°.

Three of snow with two of diluted sulphuric acid, from 32° to 9°.

Eight of snow with five of muriatic acid, from 32° to 5°.

Seven parts of snow with four of diluted nitric acid, from 32° to 2°.

Four parts of snow with five of muriate of lime, from 32° to 8° below zero.

Two parts of snow with three of crystallized muriate of lime, from 32° to 18° below zero.

Three of snow with four of pot-ash, from 32° to 19° below zero.

Three of snow with two of diluted nitric acid, from zero to 14°.

Eight of snow, three of diluted sulphuric acid, and three of diluted nitric acid, from 22° to 18° below zero.

One of snow with one of diluted sulphuric acid, from 20° to 28° below zero.

Three of snow with four of muriate of lime, from 10° to 22° below zero.

Two of snow with three of muriate of lime, from 15° to 36° below zero.

One of snow with two of crystallized muriate of lime, from 0° to 34° below zero.

One of snow with three of crystallized muriate of lime, from 8° below zero to 41°.

Eight of snow with ten of diluted sulphuric acid, 136° below zero to 59° below zero, or 91° below freezing.

The salts must be fresh, and just reduced to fine powder. The vessels should be very thin, and the materials should be mixed quickly.

COLD, a common disease, often neglected, but often injurious and fatal. The remedy is a piece of flannel to the throat, the feet in warm water on going to bed, worsted stockings and warm socks, and a purgative with 2 or 3 grs. of James's powders. These, and keeping the house, with temperance, for a day or two assures a cure.

Dr. Williams *(Ency. Pr. Med.)* states, that total abstinence from all liquids for 36 or 48 hours is a certain and infallible cure; the diet being thick puddings and vegetables, and biscuit, moistened.

*Persons exposed to intense cold.*—Rub the body gently with snow, or melted ice, or with the coldest water. Afterwards add small quantities of hot water, at intervals, so as to increase the warmth very gradually. Use artificial respiration, and as soon as the person can swallow, give warm cordials, but at first in very small quantities.

COLD CREAM.—Melt together 4 oz. of white-wax, 1 lb. of olive-oil; pour into a warm mortar, and add very carefully about a pint of rose-water. *Or*, melt together 4 oz. of spermaceti, and 1 lb. of lard. *Or*, melt together 24 oz. of spermaceti and 1 oz. of white wax, 2 oz. of olive-oil, and 1 pint of trotter-oil; add 1 oz. of essence of bergamot, and 2 pints of rose-water; beat well together, and keep floating upon rose-water. *Or*, *(Hudson's)* Melt 1 dr. of white-wax, and also of spermaceti, in 2 oz. of olive-oil, and, while warm, add 2 oz. of rose-water, and half an oz. of orange-flower water.

COLE-WORT, or *Cabbage*, *Cauliflower*, *Brocoli*, *&c. (Brassica, Caulis.)* Plants which afford copious aliment. The juice is pectoral, discussive, diuretic, and opening; the leaves vulnerary.

COLLEGES, are valuable for purposes of education, when the course of instruction is jealously guarded by some influence exterior and distinct from the professors, because in that case there will be a chance that education in them will keep pace with the age and the progress of knowledge. A collection of colleges forms a UNIVERSITY, under the controul of persons educated in it, and usually wedded to the doctrines and practices of their own youth and their predecessors. Hence knowledge in such establishments is often stationary, and maintained till quite worn out, while the rest of the world is in advance; and students are therefore obliged to learn, what they find not only useless in society but erroneous in principles. With effectual checks on this great and notorious fault, colleges, &c. are most desirable. But, hitherto, no such checks have been found, and colleges are still subject to the censures which have been made against them by learned men in all past ages.

COLOGNE EARTH, very different from brown ochre umber. Black, or blackish brown, mixed with brownish red, fine grained, earthy, smooth, polished by scraping, light, burns disagreeably. Found near Cologne; used in painting in water-colors or oil; also to render snuff fine and smooth.

COLOMBO ROOT is bitter, aromatic, stomachic, anti-emetic, and astringent. The dose is half a drachm frequently.

The *red Colombo root* is also stomachic, and bitter.

COLOUR, is the effect of the different vibrations, which the gas in a space exhibits by light reflected from surfaces, as clearly proved by Young and Fraunhofer, who have accurately determined the *breadths* of the respective vibrations that produce the several colours. These vibrations and surfaces concur in the production of coloured surfaces.

In 100 millionths of an inch, waves of red light are 2582, of green 2073, of violet 1572. Spaces between waves are black, and mingled waves are white.

In Newton's spectrum and in Young's, the ratios of reddened colour to violet are 3·5 to 1, being the exact ratio of nitrogen to oxygen in air.

COLOURS are decisive, or intermediate mechanical affections or impressions on the optic nerve. The decisive impressions are red, yellow, and blue; and intermediate impressions are orange, green, purple, and violet. If painted on a wheel, and the wheel turned briskly, the result is white from all; and all shades as different ones are omitted. The red appears to be the oxygen power, the green the nitrogen, and the blue and downward to black, the hydrogen; and the atoms which produce these elements are considered, by the author, to be the same as those which produce the colours. The prismatic spectrum is therefore a decomposition of the chemical atomic elements.

Blue and yellow form green; red and yellow, orange; and blue and red, purple. The primitive colours do not harmonize, and the compounds of two are contrasts to the order, as orange, (red and yellow), is a contrast with blue; green (yellow and blue) is a contrast with red; and purple (blue and red) is a contrast with yellow. In assorting colours this is always to be considered, and it constitutes discord or harmony.

In painting, the substances used are red and white lead; yellow and red ochres; and various woods and earths, mixed with oil, gum, or water.

COLOURING is *warm* when combined with yellows, and *cool* when combined with blues. Vermillion is *warm* from its orange tint; and Indian red *cool* from its blue tint. Red with blue is a *cool* grey, and yellow itself with blue is a *cool* green. Colours which are transparent when ground in oil, as lake, Prussian blue, umber, and terra siena, are called *glazing* colours; and, when ground in water, *wash* colours. They are, therefore, used to cover already tinted grounds, to render the grounds *warm* or *cool*.

Heralds call white, *argent*; red, *gules*; blue, *azure*; green, *vert*; purple, *purpure*; and black, *sable*.

Botanists call white, *cinereus*; reds, *incarnatus*, or *coccineus*; yellows, *flavus*, *fulvus*, and *gilvus*; blue, *cæruleus*; black, *niger*; water, *hyalinus*; brown, *fuscus*; purple, *purpureus*.

Coloured substances become paler as they are pulverized in a mortar, till at length the colour almost disappears.

The common vegetable colours are red, yellow, green, and blue.

The *red* are madder from Turkey, whose colouring matter, Turkey red, is *rubin*. Red saunders, a wood of Hindoostan; brazil wood; log-wood; lichens, or cudbear.

The *yellow* are quercitron; woad; turmeric; saffron.

The *green*, is only *sap-green*, a fleeting water-colour.

The *blue* is indigo, prepared from various species of the *indigo fera*. It has been analyzed by Berzelius, and he calls it indigo-gluten, indigo-brown, indigo-red, and indigo-blue.

Brazil wood is rendered yellow by phosphoric and citric acids, and is then a yellow dye for woollen and silk. Alkalis change it to blue or violet.

Log-wood varies from light, or orange-red to yellow. Boiling water renders it first red, and, on cooling, yellow. Acids render it first yellow, then red. Potash makes it blue and violet, and in excess brown. Oxides give a deep blue.

Cudbear, the *lichen tartareus*, is red powder, and red in alcohol, but purple in caustic ammonia, and red on paper, but the least alkali makes it purple. Dutch lacmus, whose solution is turnsole, is blue, but by acid turned red. Cudbear is a preparation of cloth for indigo, and is the popular dye for army clothing.

Acids brighten, and alkalis deepen woad.

Acids brighten the yellow of quercitron; alkalies deepen it. Cotton becomes nankeen colour prepared with silicate of potash, and immersed in a solution of quercitron.

Acids brighten turmeric, and alkalis and boracic acid deepen it to brown.

Sulphuric acid changes saffron to indigo and lilac. Nitric acid changes them to green.

Alkalis change sap-green to yellow, and acids into red.

*Schweinfurt blue.*—To form it, the following process is found to be the best. Six parts of sulphate of copper are dissolved in a small quantity of water; also, six parts of white arsenic, with eight parts of potash of commerce, were boiled in water, until no carbonic acid was disengaged. This hot solution is gradually mixed with the first, continually agitating until effervescence ceases, and an abundant dull yellowish green precipitate is formed. About three parts of acetic acid are then added, or such a quantity, that a slight excess is sensible to the smell; gradually the precipitate diminishes in volume, and in some hours a slightly-crystalline powder is deposited at the bottom of an entirely colourless solution. The fluid is poured off as soon as possible; and the powder, washed with plenty of boiling water, to remove the last portions of arsenic, is then of a brilliant blue colour.

*Fine blue, from indigo.*—The blue vat of the dyer contains indigo, de-oxidized by protoxide of iron, and rendered soluble in its yellow-green state by lime-water. If a portion of this solution be exposed to the air in a shallow vessel, the indigo will speedily absorb oxygen, and be precipitated in its usual state of an insoluble blue powder. This being dried and digested, becomes pure indigo, by the abstraction of all the resin and lime contained in it. Thus prepared, it is a fine powder, intensely deep, but softened, tender in its tint, resembling ultramarine, and does not change when exposed to the air; it is, therefore, an acquisition to the palette of no ordinary kind, and is likely to prove the most valuable of all blues, when made into cakes for wash-drawings, for the use of miniature-painters.

*Black colour*, in great perfection, is produced by the smoke of camphor, collected on a saucer held over it. With gum-water it is superior to Indian ink. The bottom at the top of the long wick of a candle is also a fine black. In all cases, blacks require finely-divided atoms, since they absorb all the light. White has surfaces enough to reflect the rays.

*Beech black*, *Blue black*. Beech wood burned in close vessels; when ground with white lead and oil, it produces a blueish gray colour.

*Frankfort black.* Made of the lees of wine, or argol, well washed and ground with water; used to make printers' ink.

*Noir d'Espagne.* Made of cork burnt in close vessels; used as a colour in painting.

*Peach-stone black.* Peach-stones, and the nuts of other stone fruits, as cherries, burnt in close vessels: ground with white lead and oil, it produces the colour called old gray.

*Vine-twig black.* Vine-twigs burnt in close vessels; blueish black; ground with white lead and oil, it produces a silver-white colour.

*Russian lamp black, Noir d'Allemagne.* Made by burning the chips of resinous deals, made from old fir-trees, in tents, to the inside of which it adheres; mixed with linseed-oil is apt to take fire by itself; used as a paint.

*Lamp black.* From distilled oil of bones burnt in lamps, with a long smoking wick; does not take fire with drying oils.

*Burnt lamp black.* Lamp black heated in a covered iron pot to get rid of its greasiness; used as a water-colour; fine bone black is sold for it.

*Wood soot.* Collected from chimneys, under which wood is burnt for fuel; contains sulphate of ammonia; it is bitter and antispasmodic.

*Bistre.* From wood soot, or peat, by pulverization and washing over; an excellent brown water-colour, superior to Indian ink for drawings, when they are not intended to be tinted with other colours.

*Ivory black,* called *Cologne black, Cassel black.* From ivory shavings, or dust, heated in covered iron pots; used as a dentifrice and a paint; with white lead, it forms a beautiful pearl grey colour.

*Bone black, Animal charcoal, Charbon animal, Noir animal.* The residuum left after the distillation of bone; reddish; used for making blacking for leather, for moulding delicate founders' work, for clarifying liquors, and for abstracting the lime used in making sugar from the syrup.

*Fine bone black, Noir de Paris.* Made from turners' bone dust, burned in covered iron skittle crucibles, and ground dry. Sold for ivory black, and, when finely levigated, for burnt lamp black.

*Prussian blue makers' black, Noir de composition.* This is the residuum from whence the prussiate of potash has been elixiviated; that of the manufactories which use dried blood, clarifies far better than bone black, or than that of the manufactories that use hoofs.

Carbonaceous matter has also been used as a clarifying powder for syrup, and many other articles.

*Rouge and pink saucers.*—These articles are prepared from the florets of the *Carthamus tinctorius,* which are kept by druggists under the name of safflower. Of this take half an ounce, infuse it a short time in a pint of water, in which a drachm of the subcarbonate of soda has been previously dissolved; strain off the liquid, to which add an ounce of finely-levigated French chalk. The alkali will hold the colouring-matter of the safflower in solution, and the chalk will remain colourless; but, by adding a little tartaric or citric acid, the alkali will be neutralized, and the red colouring matter, which is not soluble in simple water, being set at liberty, will fall to the bottom, combined with the chalk. With oil, is vegetable rouge; or, with spirits of wine, is pink dye.

A drop of hartshorn adds to the depth and brilliancy of carmine.

*Colouring prints.*—The finest colours for engravings are obtained from flowers: the blue petals of the iris afford a green fecula, but the finest green is from the ripe berries of the buckthorn. The berries of dwarf elder afford violet, changed to blue by alum. The gooseberry, cherry, raspberry, madder, and elder, also afford coloured juices. Fustic and log-wood decoctions are also used.

*Water colour for rooms.*—Take a quantity of potatoes and boil them, then bruise them, and pour on boiling water until a pretty thick mixture is obtained, which is to be passed through a sieve. With boiling water then make a thick mixture of whiting, and put it to the potato mixture. To give colour, if white is not wanted, add the different coloured ochres, lamp-black, &c. according to circumstances. It dries quickly, and is very durable.

*Colours for* ENAMELLING PORCELAIN AND EARTHENWARE.—The making of these colours is conducted profitably by persons who have assiduously watched the results of mixing metallic oxides, and metallic minerals in certain proportions, then fusing them together, and afterwards grinding for use. Chemical skill will much improve alike the processes and the colours. The following recipes will fully produce the results.

*Purple brown.*—Take 18 parts of red oxide of lead, 12 of borate of soda, 6 of silica (the ground flint of potters,) 3 of white enamel. *(See below).* Fuse well together; and, to 7 parts of this, add 2 parts of the powder of calcined protosulphate of iron. Grind for use.

*White enamel.* (1) Seven parts arsenic acid, 12 of carbonate of potass, 3 of white oxide of lead, 2 of silica, 5 of cullet, (broken flint glass), and 5 of nitrate of potass. Fuse well together, pulverize, and grind.

*Another.* (2) Fuse well together 16 parts of cullet, 5 of red oxide of lead, 1 of arsenic acid, and 1 of borate of soda.

*Another.* (3) (For glass). While submitted to the highest heat of an air furnace, stir well together 4 parts of silica, 6 of boracic acid, 2 of ground cornish stone, and 2 of tin ashes. Carefully grind.

*Yellow.*—Three parts of litharge, 1 silica, 1 oxide of antimony, and 3 oxide of tin. Fuse gently.

*Pea green.*—Five parts red oxide of lead, 4 white enamel, (above, 2,) 2 borate of soda, 1 silica, 2 cullet, and ½ protosulphate of iron. Fuse well together, and grind for use. For *yellow-green*, add to 5 of this, 1 of yellow, (above) and grind together.

*Blue.* (1) Fifteen parts cullet, 1 white oxide of lead, 4 nitrate of potass, 5 oxide of cobalt, and 1 borate of soda. Fuse carefully.

*Another.* (2) Twelve parts cullet, 5 red oxide of lead, 2 nitrate of potass, and 2 oxide of cobalt. For stone ware, add 1 of white enamel.

*Blue-green.* (1) Take 12 parts of red oxide of lead, 6 silica, 3 borate of soda, 1 oxide of copper; fuse together, and grind the whole with 6 of white enamel. (No. 2.)

*Another.* (2) Seven parts red oxide of lead, 2½ silica, 2 borate of soda, and 1 calcined sulphate of copper. Fuse well, and grind the whole with 2 of white enamel, (No. 1.)

*A beautiful green.*—Calcine 3 oz. carbonate of potass, and 2 oz. bullocks' blood, or beef; and add this to a solution of 2 oz. of sulp. iron, the *precipitate* is *green*, scarcely soluble in acids; the undissolved is *deep blue*, which is reduced to oxide of iron, either alone, or boiling with a solution of carb. potass. This causes a *green* precipitate of *iron in acids*, extremely permanent, scarcely decomposable by any acid. Carbonate of soda, also, will give a *green* precipitate, but fleeting, and decomposable.

*Orange.*—Take 5 parts of litharge, 4 of antimony, and 1 of calcined protosulphate of iron.

*Brown.*—Take 4 parts burnt umber, 4 parts yellow, (see above,) 2 of calcined protosulphate of iron, and 1 white enamel.

*Another.*—Take 6 parts litharge, 3 antimony, 2 manganese, and ¼ zaffre.

*Red.*—Take 2 parts calcined protosulphate of iron, and 5 of flux. *See* FLUX.

*Black.*—Take 8 parts borate of soda, 4 of black oxide of copper, 5 red oxide of lead, 2 silica, and 2 oxide of cobalt.

*Purple*, and *rose colour.*—Mix together 3 parts water, 2 nitric acid (strong) and 1 muriatic acid; form into equal portions, and saturate one with gold, the other with pure tin. Dilute each portion with pure water. Mix the solutions, add 30 drops of solution of silver; add plenty of water, at 212°; the *purple* precipitate is mixed with twice its weight of flux; and ground for use. The solution of gold is diluted with 3 parts of hot water, and solution of silver is added; sal ammoniac in excess is added, and the whole is agitated till precipitation ceases; then boiling water is added till the alkali is washed of; and neither heat nor stroke is applied till the precipitate *(fulminative)* is mixed with thrice its weight of flux.

*Another purple.*—By last process, treat 24 parts gold, and 24 of tin, and 3 of silver; grind with flux of 10 of borate of soda, 7 red lead, 2 silica.

*Another rose colour.*—As before stated, treat 24 parts gold, 12 of tin, 13 glass flux, 6 purple flux, (last process,) and 3 of silver.

*Balsam of sulphur.* (1) In an earthen vessel carefully boil together, from 1 to 3 hours, till of a viscid consistence, 32 linseed-oil, 4 flowers of sulphur, 2 black resin.

*Another.*—Four parts of Venice turpentine, 2 flowers of sulphur, and, when dissolved, add 8 linseed-oil. Boil 2 hours, and carefully strain through linen.

*Another, (for lustre.)* Two of flowers of sulphur, 10 oil of turpentine; boil 2 hours; cool, and after the precipitate ceases, pour off the fluid; and add 6 of oil of turpentine, repeating the heat; and when cool again, if any sulphur remain, add oil, and heat, till it is absorbed.

*Gold lustre.*—Over a slow fire, in an earthen vessel, heat gently 3 parts of balsam of sulphur, and 2 oil of turpentine. Form solutions of gold, and tin, as directed for rose colour. Mix the solutions in the proportions of 5 dwts. of each to 16 oz. of the above fluid. Then carefully *drop* into the fluid, while stirring it, till all is mixed. The brightness of the lustre (to be used with only turpentine,) will depend altogether on the careful preparation of the metals.

*Silver and steel lustre.*—In equal parts of nitric and muriatic acid, by heat dissolve platinum, till saturated. Add spirits of tar, carefully, which will cause the acids to dissipate in vapour, leaving the metal in the fluid. Evaporate, and use with spirits of tar.

*Colours for printing porcelain and earthenware.*—Whether for *black* or *blue* printing, an oil prepared by a peculiar process is indispensable. That for *black*, also the compounding of the colours, shall be first mentioned.

*Oil for oven-glaze printing.*—In an earthen vessel, over a slow fire, carefully boil 1 quart of linseed-oil, skim well, and add gradually 2 oz. of red oxide of lead; ignite the vapour, and keep it flaming almost half an hour; remove from the fire, and when cooled to 130°, mix with either of these.

Take 12 parts linseed-oil, 4 flowers of sulphur, 4 balsam of sulphur, (*See* ENAMEL COLOURS.) and 2 black resin. *Or*,

Take 8 parts boiled tar, 1 balsam copaiba, 1 oil amber, 8 balsam of sulphur, 2 acetate of lead, and 1 black resin.

*Colours, black.*—Take 16 parts black oxide of copper, and 40 of the flux, (as in *purple* enamel.)

*Another.*—Take 8 parts of enamel black, 1 of enamel blue, (No. 2.) and 1 of enamel purple, (No. 2.) Grind well together for use.

*Raven black.*—Fuse together 2 parts oxide of cobalt, and 1 of oxide of nickel, with a flux of 6 of silica, 8 of borate of soda, and 12 red oxide of lead.

*Another.*—Take 10 parts burnt umber, 3 red oxide of lead, 2 oxide of cobalt, and 3 borate of soda; use with flux in prior process.

*White.*—Take 3 parts hydrate of barytes, 2 nitro-muriate of tin, and use with flux 2 parts boracic acid, 1 nitrate of potass, 4 felspar, and 2 silica. This is for printing on drab, or other coloured bodies, either under or on an alcaline glaze. The plates are engraved *in strong line.*

*Gold, or platinum.*—From the solutions mentioned, precipitate the chlorides, and dry well. Then print by strong line plates, on felspar, or alcaline glaze.

The printer boils glue to a viscid consistence, then pours it on large dishes, cuts it, when cold, into proper sizes; rubs the oil into the plate, presses the glue *bat* on, abstracts the oil, applies the bat to the pot, on which the oil adheres, and the metallic powder is put on with a lock of cotton, and cleansed.

*For blue*, or *printing under-glaze.*—These oils are used, because adapted to preserve, (if not promote) the fine tint of the blue:—

1. Over a slow fire, in a covered earthen vessel, boil for 2 hours 2 quarts of pure linseed-oil; then add 1 quart of rape-oil, and boil half an hour; then introduce ½ pint of balsam of copaiba, 1 oz. oil of amber, 1 oz. white oxide of lead, and 2 oz. of pitch; continue the heat 2 hours longer, and it is fit for use.

*Another.* (2) Take 1 quart linseed-oil, ½ pint rape-oil, 1 oz. copaiba balsam, ¼ pint oil of tar, (or 4 oz. Barbadoes tar,) and drop in gradually ¼ pint of balsam of sulphur.

*Blue colour.*—Oxide of cobalt is the base or metal; and the *flux* (*See* FLUX, *for printing blue*,) is added in any proportion the peculiar tint of the pattern may require.

The *oxide of cobalt*, is prepared by the following processes:—Cobalt ore 6 parts is mixed with 5 of carbonate of potass, 3 of sand, and 1 of charcoal, and fused in crucibles in a close muffle. It is well pulverized, and picked; then

Take 8 parts of the preceding, and 1 carbonate of potass, and in skittle-shaped crucibles fuse; and repeat until the silicate of potass be very slightly tinged with blue.

*Or*, take 4 parts zaffres, 3 of carbonate of potass, and 1 of charcoal; treated as in prior process. Then

Take of last 20 parts, 2 sulphate of lime, and 1 borate of soda; slowly heat to fusion, then violently heat 6 to 8 hours, suddenly lower the heat, and in the bottom of the crucibles will lie the nickel.

Take of the blue, (from either the second, or the last process) picked and pulverized very fine, 30 parts, to which add 1 sulphate of lime, and ½ borate of soda, and repeat the preceding processes carefully. Dissolve a little of the oxide in muriatic acid, and when pure the solution will be entirely free from the slightest greenish tint.

COLLIMETER, is an instrument invented by Kater, for determining the exact horizontal level and zenith point, by a vessel of mercury, with an iron float, upon which is affixed a telescope and apparatus. It determines the horizontal level and zenith point to half a second.

COLOCYNTH, or the bitter cucumber, is the most valuable of cathartics; but it requires to be modified by gums and farinaceous powders. It is the basis of numerous quack medicines, and in pharmaceutical use ranks with bark, soda, mercury, alcohol, &c. It is an Egyptian and Nubian plant; and grows like cucumbers, and hence is called bitter cucumber. It is skinned and dried, and then exported in large quantities. Its proximate principle is called *colocyntine.* The drug is given in doses of four to ten grains, either as extract, or in pills, with aloes, and it is a most powerful cathartic.

COLOCYNTH, COMPOUND EXTRACT OF. Macerate 6 oz. of the sliced pulp of colocynth for four days. Strain, and add 12 oz. of extract of spiked aloes, 4 oz. of pulverized scammony, and 3 oz. of hard soap. Evaporate to thick paste, and add 1 oz. of cardamom-seeds. This is a superior and safe purgative pill of 6 grs. or half a drachm.—*See* PILLS.

COLONIES, are an extension of empire, for purposes of revenue and patronage, and Cooper says, they are war-breeders. In some cases, they are justified by the circumstance of a country, fertile in desirable products, being in possession of indolent races, who are ignorant of their advantages. This was the case with the West India Islands, where the Charibs were wild savages. North America was colonized in the expectation that it would yield as much gold as Mexico. It proved, however, a mere extension of empire. For the East India empire there is no excuse but extension and patronage, for the Hindoos have always made the most of their territory. The ambition of European Courts has, however, had the effect of peopling and cultivating America. If natives are willing to cultivate and export, no public purpose is gained by a colony—on the contrary, there is the expence of maintaining it. It is like the kitchen-garden of a London citizen, at Hampstead or Hackney—the produce costs him twice or thrice as much as it would in the open market. The benefits of colonization resolve themselves, therefore, into those of official patronage, which is no advantage to a free people, and has been the chief means of the corruptions of the British legislature. Canada, Nova Scotia, &c. in our own climate, seem to have no object but patronage. Newfoundland, the West Indies, Ceylon, &c. have peculiar products; and Malta, the Cape, &c. are great commercial positions. But we get no articles cheaper by receiving them from colonies, while the expence of the British Colonies in peace is full 1½ million, and their defence in war has cost hundreds of millions.

COLLYRI, or Eye-waters. In all threatened affections of the eye, the hand and fingers should be kept from them, and reading, &c. by fire-light or twilight carefully avoided.

1. Take 2 drs. of laudanum, ½ scr. or 10 grs. of sulphate of zinc, and mix with 6 oz. of rose-water and pure water. Apply it with soft linen rag or lint.

2. Take ½ oz. of subacetate of lead, and mix with 2 oz. of rose-water, and 6 oz. of water.

3. Take 1 oz. of distilled vinegar, 2 drs. of spirits of wine, and 12 oz. of rose-water.

4. Mix a wine-glass of French brandy with a pint of pure water.

5. Mix 2 drs. of aloes with 1 oz. of sherry and rose-water.

6. Dissolve ½ drm. of white vitriol with 2 oz. of camphor and 2 lbs. of boiling water, and strain.

7. Mix 10 drops of Goulard's extract of lead, with 6 oz. of rose-water.

8. For a more inflamed stage, mix 10 drops of extract of lead, and 20 drops of spirit of camphor with 8 oz. of rose-water.

9. When very painful, mix 10 grs. of opium with 6 grs. of camphor in 12 oz. of boiling water and strain.

COLOPHONY, is the black ashes which remain after distilling oils.

COLT'S-FOOT, *(Tussilago Farfara.)* Its leaves form the basis of most of the British herb tobaccos, and are used externally to diminish inflammation. An infusion of the dried leaves is also much used, as an expectorant in coughs and shortness of breath, as tea, or the steam is inhaled for the same purpose. A strong decoction of them is of service in scrofulous cases. The downy substance on the under-side of the leaf, dipped in a solution of saltpetre, and dried, is used as tinder. The juice drank liberally, is serviceable in calculous complaints.

COLUMBA ROOT, grows in the countries of Mozambique and Querimba, on the east coast of Africa. The authorities at the Portuguese settlements there have endeavoured to preserve to themselves a monopoly of the medicine. But, at length, an enterprising naval commander, Owen, succeeded in bringing away the living plants.

A tincture has been made from the roots of plants grown at the Mauritius, according to the formula of the London College; and it is found to be stronger, and to have a more grateful and aromatic flavour than that procured from Mozambique roots.—*Curtis's Bot. Mag.*

COLUMBIAN, is a metal of chemistry.

COLZA OIL, is extracted from the grain of the *brassica arvensis*, a species of cabbage. It is very much cultivated throughout France and the Netherlands, on account of its various useful and superior qualities. When the seed is ripe, the plant is cut, tied in small bundles, and put under a shed, or any covered and airy place, to dry. The grain is beaten out, and cleaned in the manner commonly used for wheat or other grain, and it is then treated for the oil. As the oil comes from the press it may be directly used, with potash, for the fabrication of soft soap; but if intended for burning in lamps, it should undergo preparation, to separate from it its mucilage and the colouring matter, which obstruct its clear and beautiful combustion. The method of purification consists in mixing two parts of concentrated sulphuric acid with a hundred parts of oil, which are to be well stirred until the acid combines with the mucilage and colouring matter, which are gradually precipitated in flakes of a blackish-green colour; after which, a quantity of water, equal to double that of the oil, is added; the whole is then freely agitated, with the intention of depriving the oil of the acid. It is then left to settle for the space of 10 days, at the end of which time the oil, which is upon the surface of the water, is decanted into tubs, in the bottom of which are holes filled with cotton, through which the oil is allowed to filter, when it is perfectly pure.

This method of purification is applicable to all seed-oils. The oil of Colza, thus prepared, has very little odour, is of a yellow colour, and has a sweetish taste. It is the best of all lamp-oils, and yields double the light of any oil used in England, while it is at once brilliant, white, and clear.

COMBUSTION, is the union of the hydrogen gas of the inflammable or combustible body, with the oxygen gas of the atmosphere in which it is immersed; and, with some exceptions, of hydrogen with compounds of oxygen.

Combustion disperses some bodies, and converts others into oxides. It is in all respects a convertible process. It is accompanied, too, by the most striking phenomena, and we are indebted to it for that important radiation of its action, called light, as well as another radiation called heat.

Flame is first applied to some substance containing hydrogen, in combination with some carbonaceous substance; these produce vapour, by which the adjoining oxygen is fixed; and then oxygen, parting with its gaseous motion, by its condensation becomes radiating heat; and the process proceeds, as long as any hydrogen is evolved by the heat of the fixed oxygen, and as any oxygen remains in the air to be fixed.

The products of the gases are aqueous vapour, condensed above 1000 times; and of the substance, smoke and carbonic acid gas. But, if there is a residuum, as in metal, the product of the substance is an oxide or calx, heavier than the primitive metal.

The *flame* is the white or red-hot *vapour* consumed by the oxygen in which it is diffused. The *light* is the explosive action on the atoms of gas in the space, which are radiated with the central atomic force.

The principle of combustion and flame is this—oxygen atoms will not perform their orbits in contact with *excited* hydrogen, and they become fixed, by imparting their motion to the increasing hydrogen. Unexcited hydrogen has not this power, and it may be assumed, that, owing to the sensibility of the atoms first affected, they create a force beyond the average in other equal spaces, which it requires the aid of the force of oxygen to sustain. This force is imparted as long as hydrogen is supplied; and hence the fixation of oxygen, the phenomena, and the combined results, when carbon is mingled. It happens, that excited hydrogen atoms have the power of fixing oxygen atoms, and, without this, there could be no ordinary fire or flame in the natural way; but any artificial means of condensing volumes of gas, or bodies containing gas, and appropriating the previous motions of their atoms, would afford such heat as we witness in bodies that have no hydrogen in them.

In burning, 1 ℔. of hydrogen consumes 6 ℔s. of oxygen, or 7000 grs. to 42,000 grs. but a cubic inch of hydrogen weighs but 0·02118 grs. and of oxygen 0·33888 grs.; hence, in volumes, the hydrogen is 330,480 cubic inches, and the oxygen 124,000, or 2·664 to 1. It requires those large volumes to melt 300 or 400 lbs. of ice; that is, no less than 185·55 cubic feet of hydrogen in a cube of 68·44 inches; and 71·76 cubic feet of oxygen in a cube of nearly 50 inches. If we take the mean of three determinations of ice, it is 365 lbs.; then every lb. of ice requires about half a cubic foot, or 19 grs. of hydrogen, & the fifth of a foot, 115 grs. of oxygen, to melt it; which, by other experiments, appears to expand the mercury in the Ther. 70°.

In other words, the quantities of oxygen fixed by the hydrogen of different bodies, is burning 1 lb. of hydrogen by itself, 7·5 lbs., and the ice which it melts from 3 to 400 lbs. But 1 lb. of carburetted hydrogen fixes only 4 lbs. of oxygen with a heat capable of melting 85 lbs. Oils, tallow, and ether, 1 lb. of each, fix but 3 lbs. with a heat melting about 120 lbs. of ice, and the last but 107 lbs. 3 lbs. of charcoal fix 8 lbs. of oxygen, and melt 120 lbs. 1 ℔. of sulphur exactly 1 ℔. of oxygen melting 20 ℔s. of ice. These curious results were determined by Mr. Dalton and Count Rumford.

1 ℔. of coal raises 36 ℔s. of cold water to the boiling point, and 5½ ℔s. convert it into steam. Watt allowed 84 ℔s. of coals to convert into steam 600 ℔s. of water, *i. e.* 1 ℔. of coals, or 3 ℔s. of wood, to 7¼ ℔s. of water.

The greatest known heats are those of the oxy-hydrogen blowpipe and of the poles of an extensive galvanic battery. They can only be measured by their effects, and they melt and vitrify, or disperse every known body.

By observing the effects of wires, in cooling flame, Davy invented the safety lamp, made of wire gauze, through which (owing to dispersion,) heat enough will not pass to ignite the fire-damp or sub-carburetted hydrogen.

He also applied to practical purposes the fact that flame has more heat than is necessary to raise metals to a red or white heat; and, by exposing a sheet of metal to gases before passing into flame, he afforded a light without combustion. It is the heat that precedes flame, and, in charcoal, it rises to 7000, and in other combustibles still higher, before flame appears. This principle, too, is the foundation of the spirit or platinum wire-lamp.

The *supporters* of combustion, or elements which combine with the combustible, are considered as oxygen, chlorine, bromine, iodine, and fluorine. They are also considered as electro-negative, and, with 18 elementary bodies, form acids, and with 31 others form alkalies; the set of 18 being called acidifiable bases, and the set of 31 alkalinical bases, which neutralize the acids.

Chlorine is made by pouring muriatic acid on the gray oxide of manganese. Three or four bodies burn in it with great smoke.

CHLORATE OF POTASH, is formed into crystal, by passing chlorine gas through an aqueous solution of potash.

CHLORIDE OF POTASH, is made by exposing chlorate of potash to a red heat. Two-fifths rise, as oxygen, and the residuum is the chloride.

BROMINE, ranked by the theoretical chemists with oxygen, is a factitious substance, formed in the mother-water of certain brine-springs. Some metals burn in it, but it extinguishes a taper.

Bromine, iodine, and fluorine, in their preparation, are supersaturated with oxygen, and necessarily derive all their powers, as supporters, from that element. They are, of course, to be considered as very loosely combined with it.

Despretz finds that, when equal quantities of oxygen are used for the combustion of the following substances, the annexed proportions of heat are developed:—

| | |
|---|---|
| Hydrogen | 2578° |
| Charcoal | 2967 |
| Iron | 5325 |

Phosphorus, zinc, and tin, give nearly the same quantities as iron. It appears, then, that of all bodies, hydrogen developes the least heat for the same proportion of oxygen gas absorbed; the metals disengage the most.

*Spontaneous Combustion* arises when rape or linseed-oil are united with hemp or cotton, and lamp-black added, but the last is not essential.

COMETS, are celestial meteors of irregular appearance, which descend into the solar system in lines very oblique to the plane of the earth's orbit. It may be supposed that they are unattached conglomerations of volatilized matter dispersed through space, and affected by the forces which operate in the plane of the zodiac. But the love of system and hypothesis has converted them into bodies with periodical orbits, to sustain which hypothesis very hardy assertions are made in books, &c. Two were to appear last year, 1832, and the predictions about their proximity, &c. were ominous and terrific. One was to come in October, but it was not seen in any of the 2 or 300 well-fitted observatories in Europe, Asia, and America.

COMMERCE, is merely the *personal* transaction of an individual for his own advantage or pleasure. This is its true character, whether domestic or foreign. It has no proper relation either to the public or to the government, and the modern association of imports and exports with national prosperity or adversity is a fallacy and delusion. He who acts as the trader may, by exporting products, afford employment to producers, and this may be useful to them. He may sell his goods in foreign markets at a personal profit, and thence be enabled to import in the improved value more of the products of foreigners. He may then be able to sell those foreign products at a further profit, and by this course of dealing may abstract from the public, as consumers, that which renders him relatively rich; but all this has no bearing on the government, unless it so happens that in the mutual transit the Custom-House dues are made to increase the revenue.

In no other respect is the extent of personal transactions in selling and buying, any concern of the public or government. At the same time this degree of advantage is limited by circumstances. If duties are levied on home products they do not find a market abroad, and if on imports of foreign products, they interfere with the profits of the merchant. His re-payment must depend on the home market, and this again has its limit in the discouragement which it gives to industry at home. We must consume as well as sell, or foreigners cannot pay us. Consequently, the nation is equally *plus* and *minus* as a nation, and the only profiting party is the prudent merchant. It is true that foreign products increase our variety and luxury of consumption, but it may be doubted whether this is always an advantage.

We boast in England of exporting 40 millions, at real value, per annum, and importing 43 or 44 millions; and these transactions may, as to the agents, change the distribution of personal wealth; but it has no other public or governmental operation than in regard to the Custom-House duties, and in the degree to which it may afford employment and liberal remuneration. If it do not afford profit to the merchant and master manufacturer, and competent wages to the operatives, it is labour in vain, and mere slavery to foreigners.

An indirect effect of foreign commerce is the increase of transactions by which credits and debts are increased, and thereby the capital of a country. In regard to home trade or interchanging, this is to be regarded as a convenience to some classes, by which others profit and live. It is 9 or 10 times the amount of the highest scale of foreign trade, but still it is a personal affair, or species of circle, which neither adds to, nor directly affects the aggregate wealth of the nation.

Nations usually trade themselves out; for trade begets credit, which swells capital, and this has its limit. There is then a reaction and a social disorganization. Sometimes a dissolution of the body-politic follows; at other times, a renewal of the system with diminished energies; and these circles are renewed till the social elasticity is exhausted. The duration of the periods, the renewals, and the continuance of vigour, depend on various circumstances, and the use of these on the intelligence of Governments.

COMMINATION, is the reduction of a solid to powder without changing its chemical characters, and is effected by trituration in mortars, grinding, &c. but in powder or grains it acts and is acted upon more readily and effectually. Sometimes it may be dissolved in hot water and precipitated; at others be heated red-hot in a crucible, and suddenly quenched in cold water, as in flints, stones, &c. Charcoal is best pulverized when hot; camphor yields to a little alcohol, and hot zinc to a hot pestle and mortar. A sieve best separates the parts which require further pulverization, and also best mixes different powders for medical and chemical purposes. Brittle mettles are obtained in minute parts by melting and pouring them from a heighth into cold water; and ductile ones by reducing their leaves or foil, or drawing them into fine wires. The file is also useful and necessary in some cases, and in others precipitation. Thus silver dissolved in nitric acid may be precipitated by immersing a plate of copper. Copper by a plate of iron in a solution of copper in sulphuric acid. Gold by a solution in muriatic acid, and adding a solution of iron in weak sulphuric acid.

COMPASSES, a well-known instrument in drawing and measuring. The mathematical instrument-makers sell, also, triangular compasses, beam, elliptic, proportional, trisecting, &c. compasses, and there are others used by clock-makers and lapidaries.—But, as circular parts are often wanted of larger dimensions than compasses, long rods or beams are used, called beam compasses. A string fixed at the centre, with a pencil and loop, is a convenient means of drawing large circles, and generally adopted by workmen.

COMPLEXION, an effect of climate, family, and health. Six are usually specified, as black and swarthy, chiefly African; copper, Hindoo; red, American; brown, Asiatic; white, European and South Sea Islands.

COMPOST, is a mixture of substances which separately are inert, or have not bulk sufficient. It is best made of powdered gypsum, lime-stone, unslacked lime, earth, dung, waste vegetables without seeds, bark, saw-dust, ashes, soot, mud, road-scrapings, &c. intimately mixed. It is then to be laid on the soil at a rate of from 40 to 60 cubic yards to the acre. The gypsum and lime are exactly equivalent to bones.—*Sinclair*.

COMPOSITION, is a means by which debtors and creditors desire to adjust cases of insolvency, but as this produces no *law-fees*, some attorney generally prevails on some one creditor not to come in with the rest, by which the estate gets divided among lawyers, and the creditors lose all.

For many years the traders of England have sought some legislative provision to enable a majority to conclude with the debtor; but, hitherto, the number of lawyers in the legislature has prevented its adoption. From this cause creditors for the last 30 years have lost above five millions per annum, and the wreck of this amount has been absorbed by low attornies and inferior agents of the law. The cases brought before the Insolvent Debtors' Court, and most bankruptcy cases, arise from some attorney persuading 1 or 2 creditors to hold out and bring actions; for the law, by culpable negligence or design, permits 1 or 2, against 100 or 1,000 other creditors, to render any arrangement impossible, though it often happens that time only is required, and security is tendered for distant payments in full. Under insolvencies, in the Insolvent Court, creditors have not received a farthing in the pound, and in bankruptcies it is a good estate that in some years pays 5*s*. The truth is, that owing to the wilful and wicked absurdity of the law, every unfortunate insolvent becomes hopeless and reckless; whereas, if allowed to make terms, he would not only pay his creditors, but protect his own family from impending pauperism. It is a practice of many attornies, as soon as they hear that a trader is in difficulties, to canvass the creditors, and undertake on terms to get the debt; and there are rapacious Scotch agents in London, who undertake in this way for Scotch clients, and hence no English trader ever escapes utter ruin who falls into the hands of a greedy Scotch creditor and his London agent. The law and the legislature are alone to blame, for it is a system of wholesale robbery under the law.

COMPOSITION, in the art of writing, consists in expressing in usual words exactly what you think, and neither more nor less; and in avoiding the use of any word which has not the precise sense intended. Good writing arises from accurate thinking, and is a picture of the habit of reasoning of the writer. Confusion or indistinctness in the view of a subject appears at once in the manner in which it is expressed or described. No one should, therefore, presume to write on topics of which he has not himself clear and decisive views. Long parenthetical sentences are to be avoided, and a writer becomes dull when, leaving nothing to his reader, he aims at saying all that can be said or thought on his subject. Thoughts that breathe, and words that burn, in sentences which do not weary the reader, are the essence of good writing.—*See Hugh Blair.*

COMPOSITION OF FORCES, is when 2 or more forces act on the same body in different directions. To determine the resulting direction, lines are drawn in length and angle, and their mean force, or diagonal and velocity, is the result: or, the whole may be calculated by the lines or numbers and the sines of the angles.

CONDENSER, is a syringe or squirt, as a rod, a solid piston, in a cylinder, used to force air into any receptacle. When the piston is perfect, ten times the air may be driven into a space, and it is thereby said to be condensed. At the same time it heats the apparatus, owing to the previous motions of the atoms of air being imparted to the sides.

CONDENSATION OF POWER, was an idea of Prony. He proposed that excess of power in machinery should not be wasted, but reserved for future use by being expended on the raising of weights or water, condensing air, &c. so as to be applied at other times; and, in fact, he suggested generally that the first mover should always be applied to such accumulations, and then these be expended as required, in producing effects. Water-mills, wind-mills, &c. might thus be in constant work, using at times, when power is short, the accumulations in periods of super-abundance.

CONDUCTORS, in electricity, are boundaries to excited electrics, whether the air, glass, &c. &c. As they expand the surface of the excited plate, so the electrical action appears to pass along them, and they are therefore called conductors. They are the bodies which are not electrics, which last receive excitement, and the conductors are non-electrics, and are mere boundaries, like the lead of a pipe which conducts water because no water penetrates it.

CONFECTIONARY, is the preparation of delicacies in agreeable forms and combinations, and one of the arts of domestic life.

*To make Custards.*—Put a blade of mace and a quartered nutmeg into a quart of cream; boil and strain it, and add to it some boiled rice and a little brandy. Sweeten it to taste, stir it till it thickens, and serve it up in cups, or in a dish; it may be used either hot or cold.—*Or*, blanch a quarter of a pound of almonds, beat them very fine, and then put them into a pint of cream, with two spoonsful of rose-water; sweeten it, and put in the yolks of four eggs; stir them well together till it becomes thick, and then pour it into cups.—*Or*, Take half a pound of double-refined sugar, the juice of two lemons, the rind of one pared very thin, the inner rind of one boiled tender and rubbed through a sieve, and a pint of white-wine; boil them for some time, then take out the peel and a little of the liquor; strain them into the dish, stir them well together, and set them to cool.—*Or*, boil ¼ oz. of cinnamon and 2 oz. of lump-sugar, a quart of new milk, or cream, for a few minutes. Set it to cool; and, when luke-warm, add the yolk of eggs, well beaten; strain; and set it on a slow fire, stirring till it is a proper consistence. It must not boil, or it will curdle.

*To make Macaroons.*—Take 1 lb. of sweet almonds, 1 lb. and a quarter of sugar, 6 whites of eggs, and the raspings of 2 lemons. Pound the almonds very fine with 6 whites of eggs, feel the almonds, and if they are free from lumps, they will do; then add the powdered sugar, and mix it well with the lemon raspings. Dress them in wafer-paper of the required shape; bake them in a moderate heat, then let them stand till cold, cut the wafer-paper round them, but leave it on the bottoms.

*To make Sponge Biscuits.*—Beat the yolks of 12 eggs for half an hour; then put in 1¼ lb. of beaten sifted sugar, and whisk it till it rises in bubbles; beat the whites to strong froth, and whisk them well with the sugar and yolks, work in 14 oz. of flour, with the rinds of 2 lemons grated. Bake them in tin moulds buttered, in a quick oven, for an hour; before they are baked, sift a little fine sugar over them.

*To make Cheese-cakes.*—Put a pint of warm cream into a saucepan over the fire, and, when it is warm, add to it 5 quarts of new milk. Then put in some rennet, stir it, and when it is turned, put the curd into a linen cloth or bag. Let the whey drain from it, but do not squeeze it too much. Put it into a mortar, and pound it as fine as butter. Add half-a-pound of sweet almonds blanched, half-a-pound of macaroons, or Naples biscuit. Then add nine well-beaten yolks of eggs, a grated nutmeg, a little rose or orange-water, and half-a-pound of fine sugar. Mix all well together.

*Or*, put 4 oz. of blanched sweet almonds into cold water, and beat them in a marble mortar or a wooden bowl, with some rose-water. Put to it 4 oz. of sugar, and the yolks of 4 eggs beat fine. Work it till it becomes white and frothy, and then make a rich puff paste as follows:—Take half-a-pound of flour, and a quarter of a pound of butter; rub a little of the butter into the flour, mix it stiff with a little cold water, and then roll out the paste. Strew on a little flour, and lay over it, in thin bits, 1-3d of the butter, throw a little more flour over the bottom, and do the like three different times. Put the paste into the tins, grate sugar over them, and bake them gently.

*Or*, slice a penny-loaf as thin as possible, pour on it a pint of boiling cream, and let it stand 2 hours. Beat together 8 eggs, half-a-pound of butter, and a grated nutmeg; mix them into the cream and bread with half-a-pound of currants well-washed and dried, and a spoonful of white-wine or brandy.—Bake them in patty-pans, on a raised crust.

*Or*, boil 4 oz. of rice till it is tender, and then put it into a sieve to drain; mix with it 4 eggs well beaten up, half-a-pound of butter, half-a-pint of cream, 6 oz. of sugar, a nutmeg grated, a glass of brandy, or ratafia water. Beat them all well together, then put them into raised crusts, and bake them in a moderate oven.

*To make Blanc-mange.*—Put into 1 quart of water an oz. of isinglass, and let it boil till it is reduced to a pint; then put in the whites of four eggs with 2 spoonsful of rice-water, and sweeten it to taste. Run it through a jelly-bag, and then put to it 2 oz. of sweet and 1 oz. of bitter almonds. Scald them in the jelly, and then run them through a hair-sieve. Put it into a china bowl, and the next day turn it out. Garnish with flowers or green leaves, and stick all over the top blanched almonds cut lengthways.

*To make clear Blanc-mange.*—Skim off the fat, and strain a quart of strong calf's foot jelly, add to the same the whites of 4 eggs well beaten, set it over the fire, and stir it till it boils. Then pour it into a jelly-bag, and run it through several times till it is clear. Beat an oz. each of sweet and bitter almonds to a paste with a spoonful of rose-water strained through a cloth. Then mix it with the jelly, and add to it 3 spoonsful of very good cream. Set it again over the fire, and stir it till it almost boils. Pour it into a bowl; then stir it often till almost cold; and then fill the moulds.

*To make Candied Sugar.*—The first process is *clarifying*, which is done thus. Break the white of an egg into a preserving-pan; put to it 4 quarts of water, and beat it with a whisk to a froth. Then put in 12 pounds of sugar, mix all together, and set it over the fire. When it boils put in a little cold water, and proceed as often as necessary, till the scum rises thick on the top. Then remove it from the fire, and, when it is settled, take off the scum, and pass it through a straining bag. If the sugar should not appear very fine, boil it again before straining it.

After having completed the above first process, put what quantity is wanted over the fire, and boil it till it is smooth enough. This is known by dipping the skimmer into the sugar, and touching it between the forefinger and thumb; and, immediately on opening them a small thread will be observed drawn between, which will crystallize and break, and remain in a drop on the thumb, which will be a sign of its gaining some degree of smoothness. Boil it again, and it will draw into a larger string; it is now called *bloom-sugar*, and must be boiled longer than in the former process. To try its forwardness, dip again the skimmer, shaking off the sugar into the pan; then blow with the mouth strongly through the holes, and if certain bladders go through, it has acquired the second degree; to prove if the liquid has arrived at the state called *feathered-sugar*, re-dip the skimmer, and shake it over the pan, then give it a sudden flirt behind, and the sugar will fly off like feathers.

It now arrives at the state called *crackled sugar*, to obtain which the mass must be boiled longer than in the preceding degree; then dip a stick in it, and put it directly into a pan of cold water, draw off the sugar which hangs to the stick in the water, and if it turns hard and snaps, it has acquired the proper degree of crystallization; if otherwise, boil it again until it acquires that brittleness.

The last stage of refining this article is called *carmel sugar*, to obtain which it must be boiled longer than in any of the preceding methods; prove it by dipping a stick first in the sugar, and then into cold water, and the moment it touches the latter, it will, if matured, snap like glass. Be careful that the fire is not too fierce, as by flaming up the sides of the pan, it will burn, discolour, and spoil the sugar.

*Or*, put into a pan syrup enough of clarified sugar to fill the moulds; boil it until it comes to the state called *small-feather*; skim it well, take the pan from the fire, and pour it into a small quantity of spirit of wine, sufficient to make it sparkle; let it rest till the skin, which is the candy, rises on the surface; take it off with a skimmer, and pour it directly into a mould; which keep in the stove, at 90 degrees heat, for 8 days;

then strain the candy by a hole, slanting the mould on a bason or pan, to receive the drainings; let it drain till it is perfectly dry, then loosen the paper by moistening it with warm water; warm it all round near the fire, and turn the candy by striking it hard on the table. Put it on a sieve in the stove, to finish drying it; but do not touch it while there, and keep up an equal heat, otherwise there will be only a mash instead of a candy. Spirit of wine will take off grease, and not affect the candy, as it soon evaporates.

*To Candy any sort of Fruit.*—When finished in the syrup, put a layer into a new sieve, and dip it suddenly into hot water to take off the syrup that hangs about it; put it into a napkin before the fire to drain, and then do more in the sieve. Have ready sifted double refined sugar, which shake over the fruit till covered quite white. Set it on the shallow end of the sieve in a warm oven, and turn it two or three times. It must not be cold till dry. Watch it carefully.

*To make Candied Horehound.*—Boil it in water until the juice is extracted: then boil a sufficient quantity of sugar to a great height, and add the juice to it. Stir it with a spoon against the sides of the sugar-pan, till it begins to grow thick, then pour it out into a paper case that is dusted with fine sugar, and cut it into squares; dry the horehound, and put it into the sugar, finely powdered and sifted.

*To Candy Orange-peel.*—Soak the peels in cold water, which change frequently till they lose their bitterness; then put them into syrup till they become soft and transparent. Then they are to be taken out and drained.

*To make whipt Syllabub.*—Rub a lump of loaf-sugar on the outside of a lemon, and put it into a pint of thick cream, and sweeten it to taste. Squeeze in the juice of a lemon, and add a glass of Madeira wine, or French brandy. Mill it to a froth with a chocolate-mill, take off the froth as it rises, and lay it in a hair-sieve.

*To make Capillare.*—Mix 6 eggs, well beat up, with 14 lbs. of loaf-sugar, and 3 lbs. of coarse sugar. Put them into 3 quarts of water, boil it twice, skim it well, and add a quarter of a pint of orange-flower water: strain it through a jelly-bag, and put it into bottles for use. A spoonful or two of this syrup, put into a draught of either cold or warm water, makes it drink exceedingly pleasant.

*To make Candied Orange Marmalade.*—Cut the clearest Seville oranges into two, take out all the juice and pulp into a basin, and pick all the skins and seeds out of it. Boil the rinds in hard water till they become tender, and change the water two or three times while they are boiling. Then pound them in a marble mortar, and add to it the juice and pulp; put them next into a preserving-pan, with double their weight in loaf-sugar, and set it over a slow fire. Boil it rather more than half-an-hour, put it into pots; cover it with brandy-paper, and tie it close down.

*To make Scotch Marmalade.*—Take of the juice of Seville oranges 2 pints, yellow honey, 2 lbs. Boil to a proper consistence.

*To make Hartshorn Jelly.*—Boil half-a-pound of hartshorn in 3 quarts of water, over a gentle fire, till it becomes a jelly; when a little hangs on a spoon it is done enough. Strain it hot, put it into a well-tinned saucepan, and add to it half-a-pint of Rhenish wine, and a quarter of a pound of loaf-sugar. Beat the whites of 4 eggs or more to a froth, stir it sufficiently for the whites to mix well with the jelly, and pour it in as if cooling it. Boil it 2 or 3 minutes, then put in the juice of 4 lemons, and let it boil 2 minutes longer. When it is finely curdled and of a pure white, pour it into a jelly-bag over a basin, and pour it back again until it becomes clear: set a very clean basin under, fill the glasses, put some thin lemon-rind into the basin, and when the jelly is all run out of the bag, with a clean spoon fill the rest of the glasses, and they will look of a fine amber colour. Put in lemon and sugar agreeable to the palate.

*To make Ice-cream.*—To a pound of any preserved fruit add a quart of good cream, squeeze the juice of 2 lemons into it and some sugar to taste. Let the whole be rubbed through a fine hair-sieve; have the freezing-pot nice and clean; put the cream into it and cover it; then put it into the tub with ice beat small, and some salt; turn the freezing-pot quick, and as the cream sticks to the sides, scrape it down with an ice-spoon, and so on till it is frozen. The more the cream is worked to the side with the spoon, the smoother and better flavoured it will be. After it is well frozen, take it out and put it into ice-shapes with salt and ice: then carefully wash the shapes for fear of any salt adhering to them; dip them in luke-warm water and send them to table.

*To make Water-Ices.* Bruise 2 pottles of strawberries in a basin with half-a-pint of good cream, a little currant-jelly, and some cold clarified sugar; rub this well through the tammy, and put it in an ice-pot well covered; then set it in a tub of broken ice with plenty of salt; when it grows thick about the sides, stir it with a spoon, and cover it close again till it is perfectly frozen through; cover it well with ice and salt both under and over, and when it is frozen change it into a mould and cover well with ice. Sweeten a little plain cream with sugar and orange-flower water, and treat it the same; likewise any other fruit, without cream, may be mixed as above.

*To make Black-Currant Jelly.*—Put to 10 quarts of ripe dry black currants, 1 quart of water; put them in a large stew-pot, tie paper close over them, and set them for 2 hours in a cool oven. Squeeze them through a fine cloth, and add to every quart of juice 1½ ℔. of loaf-sugar broken into small pieces. Stir it till the sugar is melted; when it boils skim it quite clean. Boil it pretty quick over a clear fire, till it jellies, which is known by dipping a skimmer into the jelly and holding it in the air; when it hangs to the spoon in a drop, it is done. If the jelly is boiled too long it will lose its flavour and shrink very much. Pour it into pots, cover them with brandy papers, and keep them in a dry place. Red and white jellies are made in the same way.

*To make Raspberry Jam.*—Mash a quantity of fine ripe dry raspberries, strew on them their own weight of loaf-sugar, and half their weight of white currant juice. Boil them half an hour over a clear slow fire, skim them well, and put them into pots or glasses; tie them down with brandy-papers, and keep them dry. Strew on the sugar as quick as possible after the berries are gathered, and in order to preserve their flavour, they must not stand long before boiling them.

*To make Orgeat Paste.*—Blanch and pound three-quarters of a pound of sweet, and a quarter of a pound of bitter almonds; pound them in a mortar, and wet them sufficiently with orange-flower water, that they may not oil. When they are pounded fine, add three quarters of a pound of fine powdered sugar to them, and mix the whole in a stiff paste, which put into pots for use. It will keep six months; when wanted to be used, take a piece about the size of an egg, and mix it with half a pint of water, and squeeze it through a napkin.

*Confection of Oranges*, is made by rasping the outer rind of oranges 1 oz. beating into pulp, and adding 3 oz. of fine sugar, in a stone mortar.

*Confection of Roses*, beat in a mortar 1 rose-leaves with 3 fine loaf-sugar.

*Confection of Almonds.*—Force the almonds from their skin by maceration, and then pound them with some gum, and with half their weight of loaf-sugar.

*Confection of Aromatics.*—Take 4 cinnamon, 4 nutmegs, 2 cloves, 1 cardamoms, 4 saffron, 32 chalk, 64 loaf-sugar, water 32. Pound the first into perfect mixture, and then add the water. Excellent for low spirits or exhaustion.

*Confection Mithridates*, is made of 3 powdered opium, 4 long pepper, 8 ginger, 12 carraway-seeds, and 12 syrup, —taken in colics and diarrheas.

*Confection, or Conserve of Hips.*—Take of the fruit of the dog-rose freed from seed, 1 ℔.; beat them into a pulp, and add 3 ℔s. of fine loaf-sugar.

CONIC SECTIONS, are the superfices which a cone presents when cut in different ways, as the circle, ellipsis, triangle, parabola, and hyperbola. The relations of these figures and curves is a curious branch of geometry, and in some cases very useful.

CONTAGION, imports the application of any poisonous matter to the body. It is applied to the action of subtile particles arising from putrid substances, or from persons labouring under certain diseases, which communicate the diseases to others; as the contagion of putrid fever, the effluvia of dead animal or vegetable substances, the *miasmata* of bogs and fens, the *virus* of small-pox, *lues venerea*, &c. &c. The principal diseases excited by poisonous *miasmata* are, intermittent, remittent, and yellow fevers, dysentery and typhus. The last is generated in the human body itself, and is sometimes called the *typhoid fomes*. Some *miasmata* are produced from moist vegetable matter, in some *unknown* state of decomposition. The contagious *virus* of the plague, small-pox, measles, chincough, *cynanche maligna*, and scarlet-fever, as well as of typhus and the jail-fever, operates to a much more limited distance through the medium of the atmosphere than the marsh *miasmata*. Contact of a diseased person is said to be necessary to the communication of plague; and approach within two or three yards of him for that of typhus. The Walcheren and African *miasmata* extend their pestilential influence to vessels riding at anchor a quarter of a mile from the shore. The chemical nature of these poisonous effluvia is not understood. They undoubtedly consist, however, of hydrogen, united with sulphur, phosphorus, carbon, and azote, in *unknown* proportions and *unknown* states of combination, or perhaps of animalculæ. The proper neutralizers or destroyers are, nitric acid vapor, muriatic acid gas, and chlorine. The two last are the most efficacious, but require to be used in situations from which the patients can be removed at the time of the application. Nitric acid vapor may, however, be diffused in the apartments of the sick without much inconvenience. These remedies apply to animalculæ as well as to gases. Bed-clothes, particularly blankets, can retain the contagious *fomes*, in an active state, for any length of time. Hence they ought to be fumigated with peculiar care. The vapor of burning sulphur or sulphurous acid is used in the East against the plague. But, it is much inferior in power to the other re-agents. There does not appear to be any distinction commonly made between contagious and infectious diseases. The infection communicated by diseased persons is usually so communicated by the product of the disease itself; for instance, by the matter of the small-pox; and, therefore, many of these diseases are infectious only when they have already produced such matter, but not in their earlier periods. In many of them, contact with the diseased person is necessary for infection, as in the itch, syphilis, canine madness; in other contagious diseases, even the air may convey the infection, as in the scarlet-fever, the measles, the contagious typhus, &c. In this consists the whole difference between the *fixed* and *volatile* contagions.

Of 45 men lately employed in cleansing the Westminster sewers, not one was attacked by any contagion, and of 54 constantly employed by the Sewer's Office in the sewers, not one had the cholera. And of 9 men employed in emptying privies, all enjoyed permanent good health, except in very foul cases, with affections of the eyes.

No subject is more embarassing to the searcher in the secrets of nature, than the nature of contagion. It seems to be internally connected with respiration and with the action of the skin, and both these subjects are almost new to physiology. The absurdity about caloric and the principle of life, of sympathy, &c. &c. have mystified past ages, and have scarcely yet passed away. Perhaps waves of light and sound are not the only waves, and life may make radiations of which the insensible perspiration is one evidence. In this, as on other subjects, we must depend on experiment, and on facts which chance may develope.

In the admirable article on contagion by Dr. Brown, in the Cyclopedia of Practical Medicine, &c. he discriminates between diseases communicated by contact, as syphilis, itch, cow-pox, &c.; and those communicable through the atmosphere, as small-pox, measles, hooping-cough, plague, typhus, &c. Hydrophobia, and glanders may be communicated by animals to man, but not by man to man. Haygarth and Clark prove that small-pox and fever do not extend their poison above a few feet, and that plague requires the inhaling of the breath. A foul or still atmosphere, dirty clothes, &c. extends the influence as new foci. Scarlatina produces its disease in from 3 to 5 days; measles 10 to 14; small-pox 6 to 21; inoculation 4 to 18; plague 3 days; typhus is immediate, or longer with previous indisposition and sudden violence. Dissection-wounds, from persons who died of other diseases, are generated by the fluids of the diseased comites, or infected clothes and furniture, and are very dangerous. Most contagious diseases appear to be engendered by morbid states, and then are capable of being propagated. The prevention is the separation of the sick from the healthy; cleanliness and ventilation; nourishing diet; attendance and relief of them; avoiding their breath, and the current of air which passes over them; and, above all, not sitting on their bed-clothes.

CONVULSIONS, in infants, and even adults, are removed by the warm bath, and the subject should be immersed to the neck, and well rubbed till the fit goes off. When children are subject to convulsions, hot water should be constantly ready. It should be rather above blood heat.

Convulsions are defined by Dr. Crawford, in the Ency. of Pr. Medicine, as a diseased action of the muscular tissues, and nerves governing them, independent of the will or brain. They are called *spasms*, when affecting the involuntary muscles, and *tremor*, when very slight and quick. Paralysis is the opposite condition. They originate in affections of the brain, spinal marrow, or ganglions, and chiefly affect persons who indicate nervous debility, by great susceptibility to external affections on the senses. The nervous system governs the muscles, and the nerves from the spine govern the muscles of voluntary motion, and those from the ganglions and great sympathetic nerve the involuntary muscles of the thorax and abdomen. Pressure on the brain varies convulsions, as it is greater or less, and may arise from blood, serous effusion, bony tumours, &c. Injury and inflammation of nerves is another cause; and they may become voluntary, as in impostors and fanatics. In full habits, they require general and local bleeding. In the fits very cold applications to the head are useful, and the warm bath for the body, especially for children, is necessary. Doses of jalap and calomel, and rhubarb and calomel, swallowed or injected, are important. The feet and hands may be immersed in a warm mustard bath, and the extremities should be kept hot and the head quite cool. When the stomach is the seat of the disorder, alkalis and aromatics, or the evacuating-pump, is the remedy. In general, tender spots are found on the spine, and these should be cupped, or leeched, or blistered, as sources of the disease.

The prevention is iron and bark tonics, and cold bathing, with warm feet; and, above all, a nourishing and easily digestible vegetable diet. In children, the gums should be lanced, whenever inflamed, and the body well rubbed. Shell-fish and indigestible meats are the primary cause of many convulsions, cramps, &c.

COOKING. 190 lbs. of beef lose 61 lbs. 2 oz. in roasting, or 32 per cent. loss. 280 lbs. in boiling lose 73 lbs. 14 oz. or $20\frac{1}{2}$ lbs. per cent. 90 lbs. in baking lose 27 lbs. or 30 per cent. 260 lbs. of mutton lost by boiling $55\frac{1}{4}$ lbs., being 21 per cent. 350 lbs. of mutton lost in roasting 109 lbs. 10 oz. or $31\frac{1}{2}$ per cent. and other mutton roasted 35 and 32 per cent.—Hence, in roasting or baking, the loss is about a third, and in boiling but a fifth. By roasting 3 lbs. produce but 2 lbs. cooked, and by boiling 5 lbs. produce 4 lbs.

COPAIBA BALSAM, (*Copai feras*,) is the product of a noble tree, which grows near the equator in South America. Near Para it is abundantly procured, by boring near the foot to the centre. The air thickens it to the consistence of oil, and turns it yellow. When pure, it concretes with calcined magnesia. It is efficacious in female complaints, and in all disorders of the urinary organs. The dose, the fifth or half a fluid drachm twice a day. The oil is rather more and the extract 10 grs. The air thickens and drys it, and it is soluble in alcohol and ether. The oil is produced by gentle distillation, the extract being the residuum.

COPAL, is a gum which exudes from certain trees in Asia and America, and forms the most durable of all varnishes, when digested and dissolved in drying linseed-oil. It is much used by japanners, coach-makers, &c. but never for oil-paintings, because inmovable without destroying the colours. It is as transparent and hard as amber, and, like it, entangles insects, proving that amber had a similar origin.

To dissolve copal, as commonly done by means of alcohol, is a very tedious process; but if a little camphor is previously dissolved in the alcohol, the solution may be effected in half the time.

COPPER, one of the most useful of the metals in various manufactories, is raised from mines in Cornwall, to the extent of 8, 9, and 10,000 tons of fine copper per annum, and Swansea, &c. produce other 2,000 tons. About 6 or 7,000 tons are exported, and a few hundred tons are also imported and re-exported. The price is from 100*l*. to 120*l*. per ton. As a British production, it is not 150 years old, and till lately Sweden supplied nearly all Europe. It is a most useful metal in alloys.

Copper is produced in twenty several forms, crystallized and native, and in combination with sulphur, iron, iron and arsenic, oxygen, carbonic, arsenic, phosphoric and muriatic acids, but the sulphurets are most common, and the ores of Cornwall. The sulphur is driven off by hand, and the residues melted to detach the iron, and then melted again with charcoal for sale.

Copper is 8·78 ductile, malleable, and in tenacity next iron. It oxidates green in air and moisture. At a red heat it absorbs oxygen, and is black. But sulphuric and muriatic acids little affect it, though nitric acid acts violently on it.

Copper is found as pyrites of copper, sulphur, and iron, and two of its native ores are oxides, so that, like other metals, it resembles potassium from the oxide potass, in its formation as a metal.

71 salts of copper have been found. There are also 18 others less known.

Copper is a metal of a red color, with a tinge of yellow, having considerable lustre, but liable to tarnish and oxydate from exposure to air. It is hard, but has considerable ductility and malleability. It has a sensible odour, especially when heated or rubbed; also a styptic, unpleasant taste, and is peculiarly poisonous.

Copper melts at a full white heat, and, by slow cooling, may be crystallized. It suffers oxidation at a lower temperature from the action of the air, thin scales of oxide forming on its surface when it is heated to redness. At a higher heat, it burns with a green flame. Exposure to air and humidity, at the natural temperatures, converts it into a green rust, which is oxide combined with carbonic acid.

The copper ores smelted in South Wales are for the most part raised in Cornwall and Devon. They consist chiefly of yellow copper ore, or copper pyrites, and the grey sulphuret of copper. The average produce in copper may be stated at one-twelfth of ore.

*Native copper*, like the metal, is red. It is found in the veins of primitive rocks, or of the older secondary. It is accompanied by several ores of copper, and sometimes of other metals. A mass was found near Lake Superior, which, by estimation, was 2,200 lbs. Native copper is frequently found in connexion with the secondary greenstone and red sandstone. Its greatest known deposits are in Cornwall and Anglesea.

*Sulphurets of copper* are ores of copper, sulphur, and portions of other metals, which, are imagined to pass into one another. The varieties are vitreous copper ore, purple copper, gray copper, and yellow copper pyrites.

*The Vitreous* is of a lead or iron-gray color, and consists of 81 copper and 19 sulphur. It occurs in veins and beds, in primitive and early secondary rocks, and is found with other ores of copper in the United States.

The *purple* occurs massive and crystallized. Its color is between copper-red and tombac-brown. That of Norway consists of copper 69·5, sulphur 19, iron 7·5, and oxygen 4. It is fusible into a globule, which acts powerfully upon the *magnetic needle*. It is found in Norway, Saxony, and England, and occurs with the other ores of copper.

The *gray* is of a steel-gray or iron-black color. It consists of 52 copper, 23 iron, and 14 sulphur; but it also contains, mixed with these constituents, other metals, in very variable proportions, as lead, antimony, and silver.

*The yellow* or *copper pyrites* occurs of various shades of yellow, and crystallized. It is brittle, yields to the knife, and may thereby be distinguished from iron pyrites. It contains copper 30, iron 32·2, sulphur 35·16, earthy matter 0·5, lead, arsenic, and loss, 2·14. It is the most abundant of all the ores of copper, and affords the copper of commerce. It exists both in primitive and secondary rocks, and is accompanied by most of the other ores of copper, sometimes galena, oxide of tin, and several of the ores of iron.

The *red oxide* varies in its shades, and is often crimson red. It consists of 88·5 copper, and 11·5 of oxygen. Red oxide of copper is also found in delicate capillary crystals, as well as massive, when it is opaque. The brick-red, or *tile copper ore*, which occurs earthy, or a little indurated, is of oxide of copper and oxide of iron, and found in primitive and transition rocks, associated with the other ores of copper.

The *carbonates* reduced by fusion, in contact with fuel, afford purer copper, as does the solution of sulphate of copper, which is met with in some mines, the copper being precipitated, in its metallic state, by immersing iron. The precipitate is afterwards fused.

The *carbonate of copper*, or oxide of copper, combined with carbonic acid, forms two species—the blue and the green carbonate.

The *blue* is found in shining, translucent crystals, whose figure is that of rhombic prisms. The color is azure-blue, frequently of great intensity. It sometimes occurs in an earthy form, as an incrustation, and is occasionly massive, without lustre. It consists of 69 peroxide of copper, 25·4 carbonic acid, and 5·4 water.

The *green carbonate* or *Malachite* occurs massive, disseminated, and crystallized. Its color is green, and the lustre of the fibrous varieties silky and pearly. It is soft and brittle, but admits of a beautiful polish, and is highly esteemed in in-layed work.

*Phosphate of copper* was formerly regarded as *malachite*, but is now known to be a bi-phosphate of the peroxide of copper.

*Muriate of copper* occurs in angular grains, of a bright-green color, among the sands separating Chile from Peru: also in minute prismatic crystals, of an emerald-green color, on brown iron stone. It tinges the flame of the blow-pipe of a bright green and blue, muriatic acid fumes are evolved, and a bed of copper remains on the charcoal.

*Arseniate of copper* forms several species, differing in relative proportions, and in the quantity of water. One variety is sky-blue and sometimes apple or grass-green, translucent, shining and brittle. It consists of peroxide of copper 49, arsenic acid 14, and not less than 35 of water. A copper mica is deep emerald-green, with considerable lustre and transparency, and consists of 58 of oxide of copper, 21 of arsenic acid, and 21 of water. Another is dark olive-green, passing into brown or yellow, or greenish-white, often transparent. It consists of 50 parts of oxide of copper, from 30 to 40 of arsenic acid, with 20 of water. Another species is a beautiful bluish-green color, but, from decomposition, often black, and when unaltered, transparent. It consists of 54 oxide of copper, 30 arsenic acid, and 16 water.

The *protoxide* of copper is of a red color, and occurs native. It is also prepared artificially, by mixing 64 parts of metallic copper, in fine division, with 80 parts of the *peroxide*, and heating the mixture to redness in a close-vessel; or by boiling a solution of the *peroxide* if copper with sugar, when the *peroxide* so gradually deoxidized, and subsides as a red powder. It consists of copper 64, and oxygen 8, = 72.

The *peroxide* of copper is also found native, but may be prepared artificially by calcining metallic copper, by precipitation from the per-salts of copper, by means of pure potash, or by heating the nitrate of copper to redness. It is 1 copper, 64, and 2 oxygen, 16, = 80. It varies in color from dark-brown to bluish-black, is insoluble in water, and does not affect vegetable blues. It undergoes no change by heat alone, but is readily reduced to the metallic state by heat and combustible matter. It combines with nearly all acids, and most of its salts have a green or blue tint. It is soluble in ammonia, forming with it a deep blue solution.

*To reduce oxide of copper.*—Mix it with a twelfth of its weight of powdered charcoal with oil, for a paste. Fuse it with a fourth of borax in a wind furnace. *Or*, fuse it with charcoal only, at full heat, for half an hour.

The furnaces in which large operations are performed are reverberatory, and of the usual construction. The calcining furnaces, or calciners, are furnished with four doors or openings, two on each side the furnace, for the convenience of stirring the ore, and drawing it out of the furnace.

The charge of ore for a calciner usually consists of three to three and a half tons. It is distributed equally over the bottom, which is made of fire-bricks or square tiles. The fire is then gradually increased; so that towards the end of the process, which lasts 12 hours, the heat is as great as the ore will bear without being fused or baked together.

The calcined ore, which is black and powdery, is then delivered to the smelters. After the furnace is charged, the fire is made up, and the substances brought into fusion. When the ore is melted, the liquid mass is well stirred; and the substances being in perfect fusion, the smelter skims off, through the front door, the sand or slags consisting of the earthy matters contained in the ore, and any metallic oxides which may have been formed, which float on the surface. As soon as the metal in the furnace is freed from slags, the smelter lets down a second charge of ore, and proceeds with it in the same manner as with the first; and this he repeats until the metal collected in the bottom is as high as the furnace will admit of, without flowing out at the door, which is usually three charges; he then opens the tapping-hole, in the side of the furnace, and the metal flows into a pit filled with water. It thus becomes granulated.

The slags having been recived in sand moulds, the blocks are broken, and any pieces found to contain particles of metal, are re-melted. Unless the slag is very thick and tenacious, the copper which they contain is found at the bottom.

The metal in the metal furnace, after the slag is skimmed off, is either tapped into water, into sand or beds. In the granulated state it is called *fine metal*; in the solid form, *blue metal*, from the colour of its surface. The former is practised when the metal is to be brought forward by calcination. Its produce in fine copper is about 60 per cent. The calcination of the fine metal is performed in the same manner as that of the coarse metal.

The melting of the calcined fine metal is also performed in the same manner as the melting of the coarse metal; the resulting product is a coarse copper, every 100 parts of which contain from 80 to 90 parts of pure metal.

The roasting is chiefly an oxidizing process. The pigs of coarse copper from the last process are filled into the furnace, and exposed to the action of the air, the temperature is gradually increased to the melting point, and the expulsion of the volatile substances that remained is thus completed, and the iron or other metals still combined with the copper, are oxidized. The charge is from 25 to 30 cwt. The metal is fused towards the end of the operation, which is continued for 12 or 24 hours, according to the state of forwardness when filled into the furnace, and is let out into sand beds. The pigs are covered with black blisters, and the copper in this state is known by the name of *blistered copper*.

The refining furnace is similar in construction to the melting furnaces, only the bottom is made of sand, and laid with an inclination to the front door.

In the process of toughening, the surface of the metal in the furnace is first well covered with charcoal.

The process of refining or toughening copper is a delicate operation, requiring great care and attention on the part of the refiner, to keep the metal in the malleable state.

Sometimes when copper is difficult to refine, a few pounds of pig lead are added to the charges of copper. The lead acts as a purifier, by assisting, on being oxidized itself, the oxidation of the iron, or any metal that may remain combined with the copper. As the smallest portion of lead, combined with copper, renders the metal difficult to pickle or clean from oxide in manufacturing, by hindering the scale or oxide from rising clean from the surface of the sheets, it must be carefully removed.

Metallic copper is oxidated and dissolved by most acids, and forms with them, in general, soluble and crystallizable salts.

Sulphuric acid, either concentrated or diluted, oxidates it, and combines with the peroxide, especially when assisted by heat. The solution is of a blue color, and, when evaporated, affords rhomboidal prisms. This salt is *blue vitriol*, and is usually obtained, either by evaporation of the solution of it, formed by the filtration of water through copper mines, or by the exposure of sulphuret of copper to the action of air and water, until the sulphur is converted into sulphuric acid, and the metal is oxidated and combined.

Nitric acid acts on copper with great energy, the metal absorbing its oxygen. Nitric oxide gas is disengaged, and the oxide combines with the remaining acid. The solution, when evaporated, affords prismatic crystals, of a deep-green color, deliquescent, and easily soluble in water. It detonates when struck with phosphorus, and it burns several of the metals. If wrapped in tin foil, the tin is oxidated with such rapidity as to inflame.

Muriatic acid slowly dissolves copper; if air is excluded, the action is inconsiderable, unless heat is applied. The solution is of a fine green color, and, by evaporation, slender prismatic crystals are obtained, which are deliquescent and soluble in water.

The combinations of peroxide of copper with phosphoric, carbonic, and other acids, are effected by adding to a solution of nitrate or sulphate of copper a solution of a neutral salt, containing the acid with which the copper is to be combined.

Copper is slowly oxidated by a number of weaker acids, as by some vegetable juices, when acted on by them with the admission of air. Acetic acid, or vinegar, forms a compound with the oxide of copper. Copper plates are exposed to the fumes of vinegar, and a crust is soon formed of a green color, which is *Verdigris.*

All salts of copper are decomposed by alkalies and earths. Potash, soda, and the alkaline earths produce precipitates, which are of various shades of green or blue, according to the quantity of alkali added, the color being green, if a small quantity is added, and blue with a larger quantity. These precipitates are *sub*-salts, the alkali absorbing the greater portion of the acid, and the precipitation retaining a portion.

Ammonia first abstracts a portion of the acid, and affords a green or blue precipitate, but, when added in larger quantity, it redissolves this precipitate, and forms a transparent solution, of a very deep-blue color, which, evaporated, affords fine blue crystals.

The triple compound *ammoniuret of copper*, is prepared by triturating together two parts of sulphate of copper with one part of carbonate of ammonia, and a triple compound of sulphuric acid, oxide of copper, and ammonia, is obtained, of a deep violet-blue color.

Copper is precipitated, in its *metallic state*, from saline solutions, by zinc and iron; either of these metals absorbing the oxygen or medium of union with the acid. *Or*, its oxide may be precipitated by albumen, and the whites of eggs have therefore been recommended as an antidote to poison of copper.

Copper is detected in mixed fluids by sulphuretted hydrogen. The sulphuret should be placed on porcelain, and digested in a few drops of nitric acid. A sulphate of copper is formed, which, when evaporated to dryness, strikes the characteristic deep blue, on the addition of a drop of ammonia.

Copper and sulphur unite by fusion, the combination being attended with heat and light. A bi-sulphuret of copper also exists in copper pyrites.

Copper combines with many metals by fusion. It communicates hardness to gold and silver, and it is employed in standard alloys, gold containing one-twelfth, and silver one-sixteenth, of the masses. With platina it forms a ductile alloy, susceptible of fine polish. With tin, it forms several valuable alloys.

About 8 or 10 per cent. of *tin* is bronze. Cannons are cast with this alloy, and bronze statues are nearly the same.

*Bell-metal* is 80 copper and 20 tin, and the Indian gong is in this proportion. The proportion of tin varies from a third to a fifth, according to the sound required. Bell-metal, 78 copper with 22 tin, is, indeed, nearly as brittle as glass, when cast in a thin plate, or gong; yet, if heated to a cherry-red, and plunged into cold water, between two plates of iron, it becomes malleable.

Copper and *zinc* form alloys of great importance, as brass. The best brass is 4 copper to 1 zinc; and, when the zinc is in greater proportion, the compounds are *Tombac*, *Dutch Gold*, and *Pinchbeck*. *Bath-metal* is 9 zinc to 32 brass; and a nearly white metal, used for buttons, called *platina*, is made of 5 zinc to 8 brass.

*Statue-metal* is 9140 copper, 553 zinc, 170 of tin, and 137 of lead. This is the composition of the equestrian statue of Louis XIV, cast at a single jet, 21 ft. high, and weighing 25 tons.

Copper is formed into *thin sheets* by being heated in a furnace, and pressed between iron rollers. These sheets are applied to the sheathing of ships, the covering of roofs, the construction of boilers and stills, &c. &c.

Copper may be *forged* into any shape, but will not bear more than a red heat, and, of course, requires to be heated often. The bottoms of large boilers are frequently forged with a large hammer worked by machinery. Bolts of copper are made by the hammer, or cast into shapes, and rolled. Copper cylinders used in calico-printing are either cast solid upon an iron axis, or are cast hollow, and fitted upon the axis.

*Plating Copper.*—The principal difficulties in plating copper ingots for rolling, are to bring the surfaces of the copper and silver into fusion at the same time, and to prevent the copper from oxiding or scaling, for which purpose fluxes are used. The flat surface of the copper ingot, on which the silver is to be fixed, must be made true by filing it, and should be left rough from the file; the ingot of silver is first annealed, and afterwards *pickled* in weak muriatic acid; it is then planished, and afterwards scraped on the surface which is to be fitted on the copper. These prepared surfaces are then either wetted with a solution of borax in water, or sprinkled over with finely-powdered borax itself, and must be then confined in close contact with each other by binding wire. When they are exposed to a sufficient degree of heat, the flux causes the two surfaces of silver and copper to fuse at the same time, and after they are become cold, they are found to be firmly united, and may be passed through the flatting-mills, in order to reduce them to the proper thickness for use.

*To remove silver from plated copper.*—For this purpose a menstruum is composed of a mixture of 3 lbs. of sulphuric acid, 1½ ounce of nitre, and 1 lb. of water. The plated metal is boiled in this menstruum until the silver is dissolved, and which is afterwards recovered from the solution by throwing into it common salt dissolved in water, which precipitates the silver.

*To make an assay of plated metal.*—Take a determinate quantity of the plated metal, put it into an earthen vessel, with a sufficient quantity of the above menstruum, and place it in a gentle heat. When the silver is stripped or dissolved it must be collected by a solution of common salt, and the precipitate must be tested off with pure lead in a cupelling furnace under a muffle.

*To tin copper*, pieces of tin are merely placed upon polished copper, which adhere uniformly to its surface. The oxidation of the tin is avoided by employing fragments of resin, or muriate of ammonia, and well regulating the temperature.

*To make ammoniated copper.*—Rub 2 parts of sulphate of copper with 3 of carbonate of ammonia in an earthen mortar. Dry the united mass, and preserve in a stoppered bottle. Doses from part of a grain to 4 or 5 grains are useful in epilepsy.

Copper plate, foil, and leaf, are in continual request in all chemical experiments.

Copper wires may be amalgamated by washing them with a solution of nitrate of mercury, washing them in water, and then dipping them in mercury.

COPPERAS, or Green Vitriol, is brought in purity from Dantzic. The English copperas contains spirit of salt, and its aquafortis is not so useful for refiners and dyers.

Copperas is also a general name applied to sulphates of copper, iron, and zinc, all of considerable use in arts and manufactures. The sulphate of copper is blue; of iron, green; and of zinc, white; and their popular name is *vitriol.*

Green vitriol is made from combinations of iron with brimstone, called iron pyrites, or, in common language, copperas stones, gold stones, or horse gold. These stones being collected in great quantity, are laid in heaps about two feet thick, upon a clay floor, surrounded by boards, that direct the rain-water that falls upon them, to flow into a cistern. The copperas-stones are five or six years before they yield any considerable quantity of strong liquor. In time, the stones turn to a vitriolic earth, which swells and ferments like leavened dough. When a bed is come to perfection, it is refreshed every four years, by laying fresh copperas-stones on the top. When a new bed is made, the work is hastened by mixing a good quantity of the old fermented earth with the new stones.

When the copperas liquor is 14 pennyweights strong it is esteemed rich. It will dissolve the shell off an egg in three minutes, and produce holes in any clothes on which it may fall.

The liquor is boiled in leaden vessels, old iron is put in at first, and more added as fast as it dissolves. The boiling is esteemed finished when a little of the liquor, put into an earthen-ware dish, and cooled, deposits crystals on the sides.

In some works, iron is added to the liquor in the cistern; and, of course, less is required in the boiling. There is another kind of pyrites, which contains a double proportion of sulphur; this sort does not alter by exposure to the weather, until the extra proportion of sulphur is removed, either by roasting in piles, or by distilling in close vessels. There is also a kind of bituminous earth, that produces copperas by exposure to the air, and from which it may be obtained by washing with water in the usual manner. Copperas is also manufactured by dissolving old iron in weak sulphuric acid, at 35° Beaumé, and crystallizing the solution.

Its color is a bright green, and its taste very astringent. A solution in water, dropped on oak bark, instantly produces a black spot. It is in request with dyers, tanners, and the manufacturers of ink, and, for their use, is artificially prepared from pyrites, which being moistened and exposed to the air a crust is formed upon it, to be dissolved in water, and, from this, crystals of vitriol are obtained by evaporation.—Vitriol is used in dyeing woollen articles, hats, &c. black, and it is the basis of ink, and used in the manufacture of Prussian blue. Reduced to powder by fire in a crucible, and mixed with powder of galls, it forms the dry, portable ink-cakes and powders.

CORAL, is the shell of a very small worm, which produces it on rocks in the Red Sea, Indian Ocean, and Mediterranean. It is at a depth, within the solar light, and at certain places there are coral fisheries and divers. The larger pieces, of most brilliant colour, fetch very high prices. The straits of Messina yield 3,000 lbs. per annum.

CORDIA MYXA. The fruit is esculent, and laxative. Bird-lime is made from it. The wood is tough and solid, and used for procuring fire by friction. One species is fine-scented Jamaica rosewood, used by the cabinet-makers, and distilled for its oil.

CORIANDER, is the name of a plant cultivated at Glazenwood and in Suffolk, which yields seeds of warm, pungent flavour, and these, by distillation, an aromatic oil. It is useful in correcting flatulency and the griping of cathartics.

Coriander is an herb eaten as a salad. The seeds are stomachic, and prevent the griping of senna.

CORK, is the bark of a species of oak (*quercus suber*) which grows in southern Europe. In collecting it, it is customary to slit it with a knife at certain distances, in a perpendicular direction, from the top of the trees to the bottom; and to make two incisions across, one near the top, and the other near the bottom, of the trunk. For stripping off the bark, a curved knife, with a handle at each end, is used. Sometimes it is stripped in pieces the whole length, and sometimes in shorter pieces, cross-cuts being made at certain intervals. In some instances, the perpendicular and transverse incisions are made, and the cork is left upon the trees, until, by the growth of the new bark beneath, it becomes loose enough to be removed by the hand. After the pieces are detached, they are soaked in water, and, when nearly dry, are placed over a coal-fire, which blackens their external surface. By the latter operation, they are rendered smooth, and all the smaller blemishes are concealed. The larger holes and cracks are filled up by the introduction of soot and soil. They are next loaded with weights to make them flat, and subsequently are dried and stacked, or packed in bales. The use of cork for stopping glass-bottles is general. It has been applied in various ways, towards the preservation of life, when endangered by shipwreck.

The floats of nets used for fishing are made of cork. Pieces fastened together make buoys, which, by floating on the surface of the water, afford direction for vessels in harbors, rivers, and other places.

In some parts of Spain it is customary to line the walls of houses with cork, which renders them warm, and prevents the admission of moisture.

In cutting corks for use, the only tool employed is a very broad, thin, and sharp knife; and, as the cork tends very much to blunt this, it is sharpened on a board by one whet or stroke on each side, after every cut, and now and then upon a whetstone. The corks for bottles are cut lengthwise of the bark, and consequently the pores lie across.—Bungs, and corks of large size, are cut in a contrary direction, a circumstance which renders them defective in stopping out air. The parings of cork are used by the makers of *Spanish black.*

Corks for bottles may be softened by rolling them under a heavy board, or by heat.

CORK JACKET, is best made as a belt, which is a long canvas or linen bag, filled with pieces of cork tied across the breast and under the arm-pits. It should contain about a lb. of bottle-corks and shavings, and if tied over the clothes it should contain 24 oz. of cork.

The *Cork-jacket* consists of pieces of cork, about three inches long by two wide, and the usual thickness of the bark, enclosed between two pieces of strong cloth or canvass, and formed like a jacket without sleeves; the pieces of cloth are sewed together round each piece of cork, to keep them in their proper situations; the lower part of the jacket, about the hips, is made like the same part of women's stays, to give freedom to the thighs in swimming; it is made sufficiently large to fit a stout man, and is secured to the body by two or three strong straps sewed far back on each side, and tied before; the strings are thus placed, to enable any wearer to tighten it to his own convenience.

CORN, the seed of certain plants, "the herb bearing seed," announced by God to man, in Genesis, chap. i., as his proper food. In India, and the East, it is rice, and, in other parts of the world, is rice, wheat, barley, oats, &c. &c. It is the staff of life, and is susceptible of exhibition in so many forms as never to pall the appetite. The simplest forms, however, satisfy many nations, and the labourers of India and the African coast seldom indulge in any food but mere boiled rice. On this they live long, and enjoy health and strength.

Long discussions have prevailed about the exportation and importation of corn, and it is one of the leading subjects of political polemics. We narrow the question, by considering a nation merely as a large farm, insulated or in a desert. It is then obvious that the master of such a farm should take good care that as much of his land was ploughed and sown as, on an average of seasons, should produce the quantity consumed in his family. This single care easily exerted is all that the case would require. Then, as every government knows the number of its people, so like the farmer, its policy and laws should be so directed as to assure a steady supply, in its own dominions, of this first necessary of life.

It may happen, that certain farms, or countries, are not fitted to produce the necessaries of life; but if so, this ought to be regarded as their misfortune, not their advantage. In this case, if by ill-chance such farms or countries are occupied by man, then dependance is greater or less, and the result must be produced by exchanges of what it does produce for what is wanted.

As a country is essentially its land, as all subjects are subordinate, and as all land is held in trust for the public benefit, it is competent to every government, as in the case of the farm alluded to, to obtain returns of the land appropriated every winter to grain cultivation, and then so to adjust its policy in rates and taxes as to assure a suitable supply for its family. If governments do not this, they are at once negligent and culpable, and, if they have not powers, then the occupiers of land are above the government, and what is so called is only a name.

All other laws, policies, rights, &c. should yield and be made to yield to this primary object of assuring to the people of a country a steady and undoubted supply of the first necessary of life. It is the foundation of national independence and perpetual prosperity.

What would the members of the family of such a farmer as that to which we have alluded, say or do, if leaving to his men the chance, and the cross purposes with which they would act in laying out his farm, when next winter came, he had no corn. They would either knock him on the head, or, in mass, desert him as a fool, and go to some other farm.

The economists will reply, that he might exchange; but why put himself in the wrong, in regard to an article of primary necessity? He might no doubt exchange, or he might not; he might do it to advantage, or he might not. His neighbours may have been as negligent as himself, and have no corn to spare, or, so little, that the exchange may be a great disadvantage. Why, from neglect or caprice, put any thing on such a subject to hazard? In a word, having the power to be independent, why not be independent? Hazards ought only to be run on points of secondary importance. No man, but a lunatic or a fool, would place his whole fortune on the chance of a card or a dice.

Again, in 99 cases in 100, it would be of no consequence whatever to a cultivator, whether he grew more or less corn. He is not cognizant of what is passing in the whole nation; this only is the proper, (though alas! the neglected) duties of the government. Tell a farmer, in January, that if he has not 20 acres more corn he must pay 50*l.*, and the seed would be in the ground within a week.

Of course, such a system bespeaks a government and a board for the purpose. If the duties were too complicated, it would be a proof that the nation was too large, and if they could not be performed it ought forthwith to be divided.

No question could properly be started, but in regard to the capacity of a country. If not large enough to grow its own corn, which ought to be made evident, then its qualifications for independence are to be questioned, and its fitness for the residence of a nation be doubted. The primary question is its capacity to subsist its own inhabitants; and, if not, it must be a colony.

These considerations include all the questions about exportation and importation laws, for all speculations in corn arise from exaggerated assumptions of scarcity or excess, and prices would be steady, if enough were known to be constantly grown. If we grew enough, the farming interest need not be crossed by importations from untaxed countries, and exportation might be permitted only when the price was a minimum, and the quantity exceeded the demand.

The British legislature have been legislating on this subject since the fifteenth century, and constantly varying their policy. At present, the landowners keep their rents and high-prices, by a duty on foreign corn, while the government derive a source of revenue from thus taxing every eater of bread. On the other hand, the manufacturers, regardless of national independence in this particular, are crying out for free imports, to enable them to exchange their productions for corn, at its price in corn-growing countries. In these contentions the land-owners, looking only to their rents, forget that cheap food is the basis of public happiness; and the manufacturers, referring to the crowded population of their districts, forget that corn itself is a manufacture whose production also employs tens of thousands.

The consumption of all kinds of grain in the United Kingdom, for 23 millions of inhabitants, is about 46 millions of quarters, independently of seed, which may be taken at an eighth; and the produce, which is about nine-fold, on various kinds of grain, wheat, barley, oats, rye, beans, and peas. Now, the importations in the last eight years have not exceeded 2 millions of quarters per annum, and less than a quarter of a million as flour; so that all these questions and difficulties about corn are raised by about 1-23d of the whole consumption. We actually produce 44 millions, and we seem to want 46, or the produce of less than another million of acres!

The proportion of arable land to pasture is at present about 2 to 3, that is, taking the United Kingdom at about 50 millions of cultivated acres, there are 20 arable for 30 pasture, and it could be no practical grievance to make it 21 to 29. In fact, at present, one-fourth is oats for the food of horses, and one-fourth of the imports are oats.

Of the present consumption 3-8ths are wheat, for men; about 2-8ths are oats, for horses; and the other 3-8ths are consumed in beer, spirits, meal, &c. &c.

Wheat, in eight years last past, has averaged 64*s*. per imperial quarter, or 62*s*. per Winchester quarter; rye, 36*s*.; barley, 32*s*. 6*d*.; oats, 24*s*. 6*d*.; beans, 36*s*.; peas, 39*s*.; about 40*s*. on the gross average, which, on about 44 millions of quarters of produce, is 88 millions of pounds sterling from 20 millions of acres of land, the gross consumption being about 92 millions worth.

After the aristocratic classes in Britain had, in passion and prejudice, expended above the value of the fee-simple of the real property, in the expences of the late wanton and wicked wars against the liberties of Europe, for the purpose of indemnity against the mortgage, they first lowered the value of money, and then levied a tax on corn, &c. so as to enable their tenantry to pay them higher rents, and thereby relieve themselves from their public mortgage. Hence, the manufacturers of England, who are obliged to sell their labours to foreign nations at foreigners' prices, are not permitted to eat bread at the prices of the same foreigners; and, in fact, are obliged to consume nearly 50 millions of quarters, at from 10*s*. to 20*s*. per quarter more than they receive in proportion for their exported goods. In an evil hour, the ignorant aristocracy permitted certain great mortgagers, or fundholders, who made their loans in depreciated currency, to restore the currency to its ancient standard, by which they doubled their claims. But, against this inadvertency, the aristocracy also seek protection in the corn duties, and, at present, labour and industry are made to shield the aristocracy from their mortgage, and also to pay the mortgagees the double amount arising from the restoration of the ancient standard. Well may there be distraction and discord in our public councils!

*Corn, smut in.*—This substance, which has been sometimes considered a mere organic disease, but more usually a parasitical plant, analogous to that which causes the mildew and the rust, and which has been described under the names of *Reticularia segetum*, *Uredo segetum*, *and Uredo carbo*, has been lately the subject of a particular inquiry on the part of M. Adolphe Brongniart, who thus describes the parts in which this malady is found, and who adopts the opinion that it is caused by the ravages of a kind of *fungus*. The axis which supports the glumes and floral organs of grasses is formed of elongated cellular tissue, the cellules of which are placed close together, without sensible intercellular passages, and of fibro-vascular bundles of false tracheæ or ducts, and spiral vessels; in the fleshy mass, of which the smut consists, no structure of this sort is visible, at whatever time it is examined; but, for examining it satisfactorily, I have taken the plant at the earliest period when the spike is capable of being examined. At this time the fleshy mass is found to consist entirely of an uniform tissue, containing uniform four-sided cavities, separated by partitions formed of one or two layers of very minute cellules. These cavities, which, in organization, resemble the regular lacunæ observable in the cells of aquatic plants, are filled by a compact homogeneous mass, composed of very small granules, perfectly spherical and uniform in size; they were slightly adherent to each other, and of a greenish colour in spikes, but little developed—distinct, or simply clustered towards the centre of each mass, and of a pale nut colour, in spikes which were a little developed: finally, at a more advanced period, the cellular partitions disappear, the globules separate completely, and the whole mass is transformed into a cluster of powder, formed of very regular globules.

CORNS.—Dr. Brown, of New York, has given the following directions for removing corns:—After bathing the foot in warm water, shave the substance with a knife, but not as to occasion bleeding; then moisten it with saliva, and rub over it the lunar caustic. The application should be extended a little beyond the edges of the corn, and continued till such a quantity adheres, as, in a short time, will change it to a dark gray, and eventually, completely black, and there is no hazard, especially on the corn itself. A little raw cotton or lint should be then applied over the part, so as to keep it from the stocking. In about four or six days the part acted upon by the caustic will peel off, including every vestige of the corn, leaving the part quite smooth.

*Corn plaster.*—By gentle heat melt together 3 oz. of rough verdigris, 6 oz. of common turpentine, 12 oz. of Burgundy pitch, and 2 lbs. of bees'-wax; spread on cloth, cut, and polish. *Or*, mix half a dram of arsenic, 4 drs. of sulphate of copper, 4 drs. of Venice turpentine, 2 drs. of rosin, and 1 oz. of bees'-wax. The corns should be cut close and picked out in the centre before the plaster is applied.

CORROSIVE SUBLIMATE, is made by the solution of the bin-oxide in muriatic acid, and evaporating till dry. It is a clear white mass in prismatic needles, sp. gr. 5·14, with acrid taste, and highly poisonous.

It was first manufactured at Venice, and long called *Venetian sublimate*. They grind 400 pounds of copperas, calcined to redness, 200 of salt-petre, 200 of salt, 180 of quicksilver, 50 of the residuum of some former operation, and also the impure sublimate, generally 20 pounds, of the last operation, moistening the whole with some of the acid that had distilled over on some former sublimation, and sublime it in glass bolt heads, covered with heads, and fitted with receivers, set in a sand heat, under which are several fire-rooms.

The process that is now used is to put 50 pounds of quicksilver into a cast-iron pot or dish, along with 60 pounds of oil of vitriol, and the pot being set upon a furnace, or, which is still better, on account of the suffocating fumes, placed in the chamber of a reverberatory furnace. The mixture is gradually heated, until a sample of the thick white mass being taken out, and thrown into some pearlash water, turns of a clear yellow colour, without any admixture of blackness. The fire being then withdrawn, and the mass cooled, it is ground with 50 pounds of salt, and 10 pounds of black manganese, left for two or three days, dried with a gentle heat, then divided into several bolt heads, and sublimed on a sand heat. There is difficulty in managing the fire at the end, so as to procure all the corrosive sublimate, and yet have it in a solid cake, for the least excess of heat melts some of it, and it runs down.

CORROSIVE WRITING.—Make a solution of indigo and madder in boiling water, in such proportions as give a *purple* tint; add to it from one-sixth to one-eighth of its weight of sulphuric acid, according to the thickness and strength of the paper to be used; this makes an ink which flows pretty freely from the pen, and when writing, which has been executed with it, is exposed to a considerable, but gradual, heat from the fire, it becomes completely *black*, the letters being burnt in and charred by the action of the sulphuric acid.

If the acid has not been used in sufficient quantity to destroy the texture of the paper, and reduce it to the state of tinder, the colour may be discharged by the oxymuriatic and oxalic acids, and their compounds. But when the full proportion of acid has been employed, a little crumpling and rubbing of the paper reduces the carbonaceous matter of the letters to powder; but by putting a black ground behind them, they may be preserved, and thus a species of *indelible writing*, or drawing, is procured.

COTTAGES are too commonly a species of hovel, with one room and a sort of closet for sleeping. But, in a well-directed country, cottages ought to be made comfortable before any palaces or mansions are built. Every cottage should have four rooms, one for common use, one for washing, &c. and two for sleeping, with ceilings ten or twelve feet high, and from two to three roods of ground attached. They would cost, according as materials were on the spot, from 40*l.* to 80*l.* and with the land might be let from 50*s.* to 70*s.*, sufficient to pay interest. A million would build 20,000.

The author of this volume has, for nearly forty years, proposed to every administration the building of milestone cottages on all the turnpike-roads, for the road labourers; and also marine cottages for aged seamen, to protect wrecks, &c. These would require 50,000 cottages, to be built by commissioners of roads, and the merchant-service, without any tax on the government.

50,000 such cottages would provide for the over-handed population, and substitute comfort for destitution and misery, accompanied by obvious public conveniences; but, such plans are not to the taste of modern statesmen. In fact, other 50,000 with immense advantages might be erected on waste lands, each with four or five acres, and public discontent become a mere speculation.

COTTON, is a soft, vegetable down, which is contained in the seed-vessels, and envelopes the seeds of the cotton plant *(gossypium herbaceum)*, and is cultivated in the East and West Indies, North and South America, and Egypt. It is an annual plant, indigenous in America, and grows to a considerable height. The fibres of cotton are extremely fine, delicate and flexile. When examined by the microscope, they are found to be somewhat flat, and two-edged, or triangular. Their direction is not straight, but contorted, so that the locks can be extended or drawn out without doing violence to the fibres. These threads are finely toothed, which explains the cause of their adhering together with greater facility than those of bombax and several *apocyneæ*, which are destitute of teeth, and which cannot be spun into thread without an admixture of cotton. In the Southern States of America, the cotton cultivated is distinguished into three kinds—the *nankeen cotton*, so called from its colour; the *green seed cotton*, producing white cotton with green seeds; and the *black seed cotton*. The two first kinds grow in the middle and upper country, and are called *short staple cotton*; the last is cultivated in the lower country, near the sea, and on the isles near the shore, and produces cotton of a fine, white, silky appearance, very strong, and of a long staple.

There are two machines for cleansing cotton from the seeds; the roller-gin and the saw-gin. The essential parts of the first are two small cylinders, revolving in contact, or nearly so. The cotton is drawn between the rollers, while the size of the seeds prevents them from passing. The saw-gin, invented by Whitney, is used for the black-seed cotton, the seeds of which adhere too strongly to be separated by the roller. It is a receiver, having one side covered with strong parallel wires, about an eighth of an inch apart. Between these wires pass a number of circular saws, revolving on a common axis. The cotton is entangled in the teeth of the saws, and drawn out through the grating, while the seeds are prevented, by their size, from passing. The cotton thus extricated is swept from the saws by a revolving cylindrical brush, and the seeds fall out at the bottom of the receiver.

North and South America, India, and Egypt, produce most of the cotton consumed, and the greater part is manufactured in England and the United States. The export from the United States, between October, 1828, and September, 1829, to Great Britain, amounted to 498,001 bales; to France, 184,821 bales; and to other parts of Europe, 66,178; total, 749,000. The crop in 1824-5, was 569,259 bales ; that of 1825-6, was 720,027 bales; of 1826-7, was 957,281; of 1827-8, was 720,593; of 1828-9, was 870,415. Of this last crop, 130,000 bales were manufactured in the United States. The whole amount of cotton imported into Great Britain, in 1832, was 280,000,000 lbs.

Europe and America are now pouring back upon Asia her own original manufacture, and underselling her in her own markets. The first impulse in this great change was derived from the inventions of Hargreave and Arkwright, between 1768 and 1780. The improved machinery consists of the cylindrical carding engine, by which the fibres of cotton are disentangled and separated from each other, and from all foreign substances, and delivered in a uniform, continuous roll. The drawing and roving frames, by which these rolls are repeatedly doubled and extended until the fibres are drawn out into a regular and perfectly parallel position. And the spinning frame, the most important quality of which is the causing the roving or preparatory yarn to pass through two or more sets of rollers, revolving with different velocities, by which the thread, at the moment of being twisted, is drawn out to any desired degree of length; the rollers performing the delicate office of the thumb and finger. In addition to these, the power-loom was brought into general use about the year 1816, by which the process of weaving is converted into a mere superintendance of two, and even three looms; each producing from 30 to 40 yards of cloth per day.

The most extensive cotton manufacture, which the world ever witnessed, is carried on in Lancashire and the borders of the adjoining counties of Yorkshire, Cheshire, and Derbyshire. How it became located there is unknown, but Roberts tells us, in the reign of Charles I., that Manchester bought thread yarn of the Irish, for warp, and cotton wool in London, for weft, which was brought there from Cyprus and Smyrna. No wool entered into these fabrics, and they were for two centuries called fustians, a term applied in common life to any mongrel article. In the reign of Anne, these Levant imports were above a million of pounds. Till 1767, the spinning was performed by the distaff, but, in that year, James Hargreave, near Blackburn, invented a machine to assist his children, (now living in abject poverty) in spinning eight threads at once. He allowed one Peel to see his machine, which he called a Spinning Jenny, and thus lost not only the benefit of his invention, but soon after he had his house destroyed by a mob of other spinners by distaff. This produced weft, but soon after Arkwright improved on Hargreave (or was assisted by Hargreave, for they went into a connection at Nottingham,) and the spinning frame was produced, which being at first turned by a water-wheel, was called *the water-frame*. It consisted of two pairs of rollers, the second of which moved with two, three, or four times the velocity of the first; and, hence, drew out the thread proportionally. Hargreave also invented the doffer, and other parts of the machinery, but dying before profits were realized, his family excited resentment, by endeavouring to establish his claims, and were repulsed, and suffered to this day to exist as paupers, while millions per annum are made by their paternal inheritance. Crompton afterwards extended the power of fine spinning, by his drawing frame, or *mule*, and to this the Rev. Dr. Cartwright added the power-loom, and other inventions. Watt and Hornblower in the meantime supplied them with cheap indefinite power in their improved steam-engines, and these are the tools with which this unparalleled manufacture has been raised. Other inventions have aided; as Dyer's card-machine, the reed-machine, &c. &c. &c.

The JENNY makes weft, the FRAME *thread*, and the MULE, the *finest thread*. The Jenny multiplies the bobbins, but the frame draws out the thread and then spins it; and it draws out by the simultaneous turning of two rollers in juxtaposition; the first of which draws out the slower or roving into threads of weft, and the other, by moving with three, four, or five times the velocity, draws it in a proportional increase of length.

This use of two rollers of an equal velocity was the invention claimed by Arkwright, and he alledged that he borrowed it from the similar application of rollers in lengthening bars of hot iron. The twist was then given by a spindle and fly, on the usual principle. The invention was afterwards claimed by one Highs, a machinist of Bolton, who made it appear that he had confided it to Kay, who sold it to Arkwright. The late Mr. W. Strutt, of Derby, asserted that Arkwright was a man of genius equal to the inventions, but the counter-circumstances here stated are derived from the late Mr. John Livesey, hair-dresser, of Leicester, who was the fellow-apprentice of Arkwright, and always spoke of his originality with contempt. He certainly claimed the crank and doffer, which were proved to be the invention of poor Hargreave.

After the cotton has been ginned and picked, or batted, that is, beat up and separated into a light uniform mass, the first operation of the manufacturer is *carding*, which serves to equalize the substance of the cotton, and dispose its fibres in a parallel direction. The *carding-engine* consists of a revolving cylinder, covered with cards of iron wire, which is nearly surrounded by a fixed concave framing, also lined with cards, with which the cylinder comes in contact.

From this cylinder, called the *breaker*, the cotton is taken off by the motion of a transverse comb, called the *doffing-plate*, discovered by Hargreave, and it passes through a second carding in the *finishing* cylinder. It is then passed through a kind of funnel, by which it is contracted into a narrow band or sliver, and received into tin cans, in the state of a uniform continued carding.

The next step in the process is called *drawing* the cotton. The machine employed for this purpose, called the *drawing-frame*, is constructed on the same principle as the spinning-frame or jenny, discovered by Hargreave, from which the idea of it was taken. To imitate the operation performed by the thumb and finger in hand-spinning, two pairs of rollers are employed; the first pair, slowly revolving in contact with each other, are placed at a little distance from the second pair, which revolve with greater velocity. The lower roller of each pair is furrowed, or fluted, longitudinally, and the upper one is covered with leather, to give the two a proper hold of the cotton. If a carding be passed between the first pair, it will be merely compressed by the pressure of the rollers; but, if it be then passed through the second pair, moving with twice or thrice the velocity of the first, it will be drawn twice or thrice smaller than it was when it entered the first rollers. The relative velocity of the two pairs of rollers is called the *draught* of the machine, and this was the discovery of Arkwright.

Several of these drawings are then passed together through rollers, in the same manner, *plying* (coalescing) as they pass, and forming a single new drawing. The drawing and plying are several times repeated, and have the effect of arranging all the fibres of the cotton longitudinally, in a uniform and parallel direction, and doing away all the inequalities of thickness. In these operations, the cotton receives no twist.

*Roving* the cotton, which is the next part of the process, gives it a slight twist, which converts it into a soft and loose thread, called the *roving*. The machine for performing this operation is called the *roving-frame* or *double-speeder*. In order to wind the roving upon the bobbins of the spindles, in even cylindrical layers, the spindle-rail is made to rise and fall slowly, by means of heart-wheels in the interior of the machine. And, as the size of the bobbins is augmented by each layer, the velocity of the spindles and of the spindle-rail is made to diminish gradually, from the beginning to the end of the operation, another invention of Arkwright. This is effected by transmitting the motion to both, through two opposite cones, one of which drives the other with a band, which is made to pass slowly from one end to the other of the cones, and thus continually to alter their relative speed, and cause a uniform retardation of the velocity. The bobbins are now transferred to the *spinning-frame*, which has a double set of rollers, like those described in the account of the drawing and roving-frames, and which, operating in the same manner as in those machines, extend the rove, and reduce it to a thread of the required fineness. The twist is given to this thread by flyers, driven by bands, which receive their motion from a horizontal fly-wheel, or from a longitudinal cylinder. The yarn produced by this mode of spinning is called *water-twist*, from the circumstance of the machinery, from which it is obtained, having been, at first, generally put in motion by water.

In 1775, the *mule*, between Hargreave's jenny and Arkwright's horse-engine, was invented by Samuel Crompton, of Bolton. The spindles are mounted on a moveable carriage, which recedes when the threads are to be stretched, and returns when they are to be wound up. The process of stretching is intended to produce threads of the finest kinds, and consists in forcibly *stretching* portions of yarn, several yards long, in the direction of their length. The purpose of it is to reduce those places in the yarn which have a greater diameter than the rest, so that the size and twist of the thread may become uniform throughout. Here ends the process of spinning, and that of weaving begins.

Bates's patent for an American machine, for roving cotton, silk, or flax, by a drawing-frame, and afterwards for twisting or spinning the sliver in a bobbin-frame. Both frames may be worked together, and they are reported to the Author, by manufacturers, to be very complete and efficient. There is a heckle belt, for preparing the sliver, with various pullies, rails, and forcing-plates, to facilitate the operation of a drawing-roller, when the filament passes to the bobbin-frame, which has a contrivance for stopping when a thread is broken. The whole is very compact and original.

In the printing of calicoes, equally important improvements have been made. Instead of the tedious process of impressing patterns from wooden blocks, the most delicate patterns are transferred from copper cylinders with astonishing rapidity; and two, and even three colours are, in this way, imprinted at one operation, though in richer and more expensive patterns, block-printing continues to be used, in addition to the impressions from the cylinders. Chemistry has also contributed its share of improvement in the new process of bleaching by chlorine, and in many new combinations of colours. In its present state, the entire manufacture, in its various departments, presents a greater combination of human skill than can be found in any other art or manufacture. In 1781, the quantity of cotton wool imported into Great Britain was 5,000,000 pounds; in 1832, it was 280,000,000, and, allowing 200,000 is for export, 276,000 pounds remained as the manufacture of the kingdom. Of this, upwards of 83,000 pounds were exported in yarns, valued at 4,721,796*l.* sterling, and the value of all other manufactures of cotton, exported in 1832, was 12,622,880*l.* Some estimate the annual value of the cotton manufactured in Great Britain as high as 36,000,000*l.* In the early periods of this manufacture, the profits were enormous. They built Manchester, Stockport, Bolton, Blackburn, &c. &c. &c.; and Glasgow and Paisley; and have been estimated to give employment to half a million of persons. In 1826, an unprecedented reduction in the prices of cotton manufactures, and in the value of property engaged in it, spread wide and general distress throughout the districts devoted to this manufacture, which has continued, with greater or less intensity, down to 1833. There is no diminution in the quantity of cotton consumed, but there is abundant evidence, that neither the capital nor labour employed in it are now receiving a fair remuneration. The fall in the prices of cotton manufactures, from 1814 to 1832, would seem, by a comparison of the real or declared value of the exports with the official value, rated by a uniform list, to have been in the proportion of 106 to 34.

In the United States, the progress of this manufacture has partaken of the characteristic energy and vigour of the country. It is only since the introduction of the power-loom that it can be considered as having been established on a permanent basis. The scarcity of skilful weavers, and the high prices of weaving, had been found serious obstacles to its success, which was secured by this invention. The first successful experiment was made at Waltham, Massachusetts, in 1815, applied to the coarser fabrics; but so rapid has been the extension, that besides furnishing the United States with its full supply of the more staple productions, and a considerable export of coarse goods, the finest prints of Manchester and Glasgow are imitated in great perfection; and more than half the consumption of the Union, in this important branch, is now furnished from native industry.

The actual extent of this manufacture, in the United States, in 1830, was estimated at 35,000,000 pounds of cotton per annum, manufactured into 140,000,000 of yards of cloth, of which about 10,000,000 were exported, and upwards of 20,000,000 printed. Several improvements, originating in America, have been introduced, and the whole process is performed there with as great advantage as in any part of the world. The descriptions of cottons exported are mostly the coarse fabrics, and known abroad by the name of *American domestics.* They have been extensively imitated by the English, and a competition is going on for the foreign markets. It is thought that the possession of the raw material on the spot, and the use of the comparatively cheap moving power of water, instead of steam, with the proximity of the great markets of South America, are advantages, in favour of the United States, more than sufficient to counterbalance some disadvantage in the higher cost of machinery, and, as is commonly supposed, in the higher wages of labour. But the labour in the cotton-mills being wholly performed by American females, has been ascertained not to be dearer than the same description of work in England. The price of coarse cottons, in 1829, was less than one-third of the price in 1815.

The increase of the production of the raw material is even more wonderful than that of the manufacture. In 1791, the whole export of the United States was 64 bags, of 300 pounds each; the average of 1826-7, and 8, 235,000,000 pounds; and, if we include that consumed in the country, the average production was 270,000,000 pounds, valued at 6,000,000*l.* sterling; the price being one-third of that of 1815. This reduction of price seems destined to cause a still further immense extension of the manufacture, which is rapidly taking the place of hempen sail-cloth, and the different descriptions of coarse linens. In fact, this valuable material, at once delicate, strong, and cheap, seems equally well adapted to every fabric, from the gossamer-like muslin of the ball-room to the coarse garment of the Negro.

The consequence of British inventions has been an increase of the consumption of cotton, in Britain, from five millions of lbs. in 1781, to nearly 300 millions in 1832, besides a consumption of 200 millions in France, the Netherlands, United States, &c. by the same machinery.

The chief part of this immense supply is derived from Georgia, South Carolina, Tenessee, and Louisiana, where the crops have been increased from a few lbs. in 1790, to upwards of 300 millions in 1831. The other supplies are from Brazil, the East Indies, and Egypt; but, altogether, not a third of that from the United States.

The qualities are indicated by the market prices.

The best is called Sea Island, and it grows on Sandy Islands and the low coast of Georgia, and fetches double any other, and three times the East India. It has been 4*s.* 6*d.* per ℔.; but, for several years, has run from 11*d.* to 20*d.* according to condition.

The upland Georgia and Louisiana brings but 6*d.* or 7*d.* The Egyptian 8*d.* or 9*d*, the Brazil 7*d.* to 9*d.*, and the East India but 4*d.* or 5*d.*

It employs altogether half a million of men, women, and children. The steam-engine power employed is that of 25,000 horses, in about 400 engines, which consume 560,000 tons of coals.

The raw cotton, at 8*d.* per ℔., as 300 millions of ℔s. costs 10 millions, the exports at *official* value were, in 1830, 36,369,000*l.*, and, at *declared* value, 17,395,000*l.* If the home consumption is equal to the export, then the produce would be nearly 35 millions, leaving about 25 millions for wages of labour, expences, and profits. The wages, however, of half a million, at 10*s.*, would be 13 millions; the expences of coals, machinery, and buildings, at least 10 more, leaving but 2 millions of profits to 5000 master manufacturers, or an average 400*l.* per annum on a capital valued at 40 millions, or just 5 per cent.

In this result, every Manchester manufacturer will agree with us; though a certain dogmatical eulogist of modern policy makes the profit above six millions, or above 10 per cent. on a capital of 56 millions.

In truth, nothing can be more wretched, illusory, and grinding, than all the details of the cotton manufacture; and it is only by superceding human labour, step by step, that the returns can be made equal to the expences. The flippant observation that, if so, it would not be carried on, and even increase, is a fallacy bottomed in ignorance; it arises from the commitment of capital, and the habits of industry, and the increase is the effect of recklessness in many, and of the necessity of making more and more in all to meet expences and engagements. Thus many factories work night and day to increase their returns, meet rents, &c. &c.; not because there is a demand, or great profits, but, in truth, because profits are so low, and the demand is no concern of each.

It is from this cause that all cotton articles are sold at a price which often shocks even the purchaser, as good calicoes at $2\frac{1}{2}$*d.* per yard and cotton stockings at 8*d.* per pair.

The relative extent of the fibrous manufactures may be conceived by the exports of each in 1829.

| | |
|---|---|
| Cotton . . . | $17\frac{1}{4}$ |
| Wool . . . | $4\frac{2}{3}$ |
| Linen . . . | 2 |
| Silk . . . | $\frac{1}{4}$ |

The home consumption does not appear; but, taking the cotton as equal, the woollen as quadruple, the linen at treble, and the silk as forty-fold, the whole manufactories may be taken—

| | | |
|---|---|---|
| Cotton | . . . | 34½ |
| Woollen | . . | 18 |
| Linen | . . . | 6 |
| Silk | . . . | 10 |

Altogether, far short of the value of corn produced per annum, or butcher's meat; and secondary to metallic products, and to the aggregate of miscellaneous farming produce.

In yards the exports of cotton fabrics are abou 450 millions, value 13 millions, or about 7*d.* per yard; and in lbs. the cotton-twist exported is 64 millions for 4 millions sterling, at 15*d.* per lb., the chief part of the latter going to Germany and Russia.

The cotton manufactory maintains its locality in Lancashire, just as other manufactures maintain their locality, owing to the congregation of artizans and skilful workmen on the spot, and this is the reason why it is so difficult to transplant any manufactory to other sites and other countries.

COUGH, a deep inspiration of air, followed by a sudden and violent expiration, excited by a sensation of some irritating cause in the lungs or windpipe. The sudden expulsion of air from the lungs is produced by the violent contraction of the diaphragm and the muscles of the breast and ribs. These parts are thus affected by a sympathy with the organs of respiration, which sympathy springs from the connexion of the nerves of the different parts. The sensation of obstruction or irritation is most commonly confined to the *trachea*, or wind-pipe, and especially to its aperture in the throat, termed the *glottis*. This disease is generally considered unimportant, particularly if there be no fever connected with it. But every cough, lasting longer than a fortnight or three weeks, is suspicious, and ought to be medically treated. Another common cause of cough, which has its seat in the lungs, is inflammation of those organs, whether in the form of pleurisy or peripneumony. These diseases do not differ very essentially, except in violence and extent, from the acute catarrh, but are more dangerous, and more rapid in their progress, and the constitution is excited to a highly-febrile condition. Another frequent origin of cough is the rupture of some of the blood-vessels of the lungs, and the consequent effusion of blood into the cells, which is expelled by the cough that its irritation excites, constituting what is technically termed *hæmoptoe*, *hæmoptysis*, or spitting of blood. When the vessels of the lungs are thus ruptured, they seldom heal readily, but degenerate into ulcers, which pour out a purulent matter; and, by this discharge, the vital powers are gradually worn down and destroyed. This is a common source of consumption, or *phthisis pulmonalis*. A cough is excited, and the same fatal disorder is also induced by the existence of tubercles in the lungs. These are little tumours, which gradually inflame and ulcerate, and produce the same consequences as the ulcerations from *hæmoptysis*. Inflammation of the heart, and of the *pericardium*, or membrane surrounding it, is also accompanied by cough, and other symptoms, not easily distinguishable from those of pleurisy and peripneumony. Where a cough is excited by disorders of parts external to the cavity of the chest, it is generally dry, as the irritating cause is external, and not any obstructing matter in the lungs themselves. Disorders of the viscera of the abdomen, especially of those which lie in contact with the diaphragm (the muscular curtain separating the cavities of the belly and chest,) frequently induce a cough. A short dry cough invariably attends inflammation of the liver, whether acute or chronic, and accompanies the various tubercular and other obstructions in that organ. Hence inflammation of the liver is not unfrequently mistaken for inflammation in the lungs; and, in some of the chronic diseases of the liver, the cough is occasionally complained of as the most urgent symptom. The presence of pain in the right side, shooting up to the top of the shoulder, the dryness of the cough, and pain, enlargement, hardness, or uneasiness, on pressure below the ribs of that side, will afford the best means of distinguishing whether a disease of the liver is the origin of the cough.

COUGH LOZENGES.—Mix 8 oz. of gum arabic, 4 scr. of aniseed and of Kerme's Mineral, 2 oz. of liquorice-juice, 12 grs. of extract of opium, and 2 lbs. of white sugar. *Or*, In mucilage of gum dragon 3 lbs., mix 2 drs. of ipecacuanha, and 2 lbs. of sugar. Make 480 lozenges.

COUNTER, was the name of an apparatus, invented by Watt, to record the strokes of the beam of his steam-engine. His bargain was to receive the value of a third of the fuel saved, and, to check this, an instrument, locked up, stood in the engine-house, which recorded the work done from one period of examination to another. This proved to him and his partner a source of vast revenue, a single mine, in Cornwall, after some time, agreeing to compromise at 2400*l.* per annum.

COURT PLASTER, *(Sticking Plaster.)*—In 12 oz. of alcohol dissolve 1 oz. of isinglass, and 2 oz. of tincture of benjamin. Brush this five successive times, at intervals, over strained black silk, or on gold-beaters' skin. Then add on this, twice, a mixture of scio turpentine 4 oz. and tincture of benjamin, 6 oz., to prevent cracking; then brush over all black Peru balsam.

*Or*, In 1 oz. of compound tincture of benjamin and 2 oz. of water, dissolve 4 oz. of isinglass.

*Or*, In 8 oz. of alcohol dissolve 3 drs. of each of isinglass, gum benjamin, and gum storax; and, while heated, spread on the silk, preserving the tenuity by more alcohol. *Or*, mix 1 oz. of balsam of Peru with 2 oz. of gum dragon.

COW, an animal of great domestic value, in Britain, affording milk, butter, and cheese. The Herefordshire, Ayrshire, Alderney, and short-horned cows, yield the richest milk; and Suffolk and Yorkshire the greatest quantity. A cow may be kept on from 2¼ to 3 acres of good grass land, new or old, and gives from 2 to 3 galls. of milk for 9 months out of 10.

Meadow-land for tender hay for cows is mowed two or three times per summer.

It is estimated that 3 galls. of good milk give 1 lb. of butter; but cows that yield most milk do not produce most butter; and some which yield 7 galls. per day, do not afford above 5 lbs. per week of butter.

The present Middlesex price of cows is about 10*l*. or 11*l*. in the autumnal months; and from 12*l*. to 15*l*. in spring. On the average, a cow affords a quart of cream, or 1 lb. of butter, per day, and 2 galls. of milk once skimmed.

Their period of gestation is nine months, and they may be milked till within a few weeks of the time. For swellings of the udder, rub it three times a day with equal parts of olive-oil, hartshorn, and a little oil of origanum.

COWHAGE, *(dolichos,)* is used for expelling worms, by mixing the hairs of the pods with treacle. A tea-spoonful for three days should be followed by a purge.

COW-POX, the small-pox, modified by the cow, and serving as a preservative against that malignant disease, in some cases perpetually, and in others only for a term of years. It is communicated by inoculation, either with a lancet or needle and thread, from the cow directly, or from the pustule in the human subject. It ought to rise in a large rose-like pustule, and to be attended with slight fever to produce the constitutional effect, and act as a preservative. Any other disease of the skin, or even a pimple, will supercede it. A single aperient before and after is all the medicine necessary. It has saved the lives of a sixth of the living generation.

From tables it appears that the annual mortality in cases of small-pox, when reduced by vaccination, in Copenhagen, was from 450 to 9; in Prussia, the average was as 12 to 1; Berlin, in 1819, only 25 had died, being about 1 in 8000; Bavaria, in 11 years, only 5 had died; Anspach, the disease had been completely exterminated; Norwich, in one year, the small-pox cut off more persons than any disease, except the plague; Edinburgh, similar havoc; London, in one year, 13,000 died; Russia, from 1804 to 1812, there were upwards of 1,200,000 individuals vaccinated. The various causes of failure are, age of virus, want of care, bad selection, &c. &c.

CRAMP, a severe spasm, or convulsion, often affecting the lower extremities in bed, and relieved either by drawing up the toes towards the instep, by standing on cold stone or iron, or by taking calcined magnesia in peppermint-water. When in the stomach, the relief is the application of a tin or earthen vessel, filled with hot water; or hot towels and fomentations, friction of the abdomen, with magnesia, in some aromatic or sal volatile, ether, or laudanum.

CRANES, to raise heavy bodies from one level to another, are generally wrought by a windlass, or double windlass, with a ratchet and catch, to rest or stop. Sometimes they are worked by men or horses walking within a wheel, a clumsy and dangerous contrivance. Hardie's is the common gaol tread-wheel, and very good. There are a great variety, and some patent cranes, but the object of all is the same, to shorten a chain or rope fastened to the body to be raised. Sound tackle and moderate speed are the chief points.

CRANK, is a bent axle, by which an alternating or reciprocating motion at the joints, or remoter deflections, turn the axle, and that of any pinions, and these cogs and machinery. It was first applied, three centuries ago, to communicate the reciprocating motion of the treadle of a common spinning-wheel to the axle of the wheel, and has been since applied and preferred in communicating the reciprocating motion of the lever of the steam-engine piston to machinery. It is sometimes double, with opposite motions, and sometimes treble, with motions 120° distant.

The crank applied to the doffer of a cotton-machine was an invention of Hargreave, and it rendered that operation perfect.

CRAYONS.—The simplest crayon for learning or for workmen, is made of pipe-clay, wet, rolled, and put in a port-crayon or holder. In drawing with it, on a wall or board, he should support his right arm on a stick held by the left hand, such as is used by all painters, and called the *maul-stick*. It confers greater freedom in the right hand. This pipe-clay crayon, as a relief to lines on paper, of a middle tint, drawn with red or black crayons, gives a rich finish to a drawing.

*To make Crayons.*—To 1 pint of boiling water, add 1 lb. of very finely-ground bone ashes, and 3 oz. of spermaceti, coloured with ochre, &c. as required, roll out the paste, and, when half dry, cut in lengths.

CREAM FROM MILK.—Put zinc or spelter into the milk-pan, or put the milk into a vessel made of zinc, and the same quantity of milk will yield a greater quantity of cream or butter, and of a much finer flavour than could otherwise be obtained; besides which, the acrimonious substance that causes milk to become sour, or rancid, will be decomposed.

*Iced Cream.* Take 2 pints of new milk, the yolk of 4 eggs, and a quarter of a pound of white sugar. Rub them together, strain, heat gently, and cool gradually. Put 2 pints into a covered icing pot, capable of holding twice as much, keep cool in a pail of ice; bruise ice, 6 lbs. mix it in a deep pan, with salt, 2 lbs.; throw some of this mixture into the hollow made by the icing-pot, and every five or six minutes open the pot, and break down the ice that forms on the inside of the pot, that the whole may be converted. It may be flavoured with coffee or vamille, or pistache, or any syrups at pleasure.

CREAM OF TARTAR, or purified tartrate of potash, is made from the deposits on casks, during the fermentation of wine, by solution in water and crystallization; then boiling the crystals with some white argillaceous earth, and finally evaporating. *Or*, it may be dried in iron vessels, pounded, dissolved in hot water, and crystallized; then redissolved, and clarified with white of egg and ashes.

Cream of tartar exists in grapes and tamarinds, and the dregs of wine contain a considerable quantity of it. It contains a very considerable proportion of super-tartrate of potass, about seven or eight hundredths of tartrate of lime, and a small quantity of silica, albumen, iron, &c. It may be dissolved in 15 parts of boiling water, and 60 of cold water; and it may be rendered much more soluble by mixing it with boracic acid or borate of soda, which renders the cream of tartar soluble in its own weight of cold water. This preparation is known by the name of *soluble cream of tartar*. Its aqueous solution is soon decomposed by the contact of the air.

It is obtained by dissolving in boiling water the common tartar—a white or reddish crystalline matter, which forms on the internal sides of the vessels in which wine has been kept—mixing with it some clay, which precipitates the colouring matter, and then permitting the liquor to crystallize.

CREDIT, the effect of opinion, and of general and individual confidence; constituting *the prosperity and wealth of nations.* No subject is so important, and yet so little understood. Every man who does not live by labour paid by the day, lives by giving or taking credit. A man cannot eat or drink specie, and his revenue from it must be derived from lending it for a current interest. This he does by giving credit to the borrower; so that the beneficial use of all transferable property implies, at once, a creditor and a debtor. If the money or currency in Great Britain is worth 60 millions, no revenue can be made from it but by lending it or using it, so that credit is given to somebody, or something, as a means of making it beneficial. But credit goes further, and it becomes itself capital when any one enjoying confidence lends his credit to others, as a country banker or the Bank of England, who issue notes, or a banker or trader of credit, who accepts bills payable at a distant period; and in this way the current capital of England has been raised to several hundred millions. So in regard to merchandize sold on credit; it is, for the time, capital to the receiver, and pays interest to the dealer; so that this species of credit increases the capital by all the consumption or transactions in the period of the credit. In this way credit multiplies the resources of a people and generates the national wealth.

Two circumstances are always necessary to render a nation rich; one is credit or confidence, and the other transactions or industry. The transactions develope credit, and credit sustains transactions. Buying with the current stock of money would leave a people constantly in the same condition. But credit for a period, and the increase of transactions, generates surplusage. Venice, Genoa, Holland, the Hans Towns, and Great Britain, have had credit and transactions, or industry, and hence they became rich. Each remains, and of the same bulk, but the credit and transactions having disappeared, some have decayed and others are decaying. Transactions depend on profits, speculation, and rising prices; credit takes prospective views, and lowers as transactions afford less promise, and hence their effects are simultaneous. Previous, however, to final stagnation, there is a stuggle to maintain the value of capital committed in enterprizes, trade without profits, and reckless and desperate adventure, all of which accelerate decadence.

When we say that transactions are necessary to the developement of wealth, by means of credit, we explain the cause of the constant association of foreign trade with wealth. It begets credits, and this, in fact, constitutes its shew of wealth. The foreign merchant imports luxuries, the consumption of which begets no wealth; but his transactions cause many credits to be developed, and this is the true secret of the apparent wealth of foreign trade. There may be enjoyment in the consumption of luxuries and foreign produce, but no wealth. The merchant may fill his own coffers, by abstracting from the community, and the dealers may develope their credits, by which a shew of wealth results; but, it is mere shew, and an endless circle of definite individual operations.

Rivals then take advantage, for Prosperity has fostered Envy. Genoa rose on Venice, Holland on the Hans Towns, Great Britain on Holland and the United States, and other nations are rising by the decadence of Britain. The limit of prosperity seems to be fixed by political ambition and the powers of credit. The former rises with wealth, and the latter requires to be husbanded. Its tendency is to exceed its strength, but it is too delicate and subtle to be rudely experimented on. Ruin is inevitable if political ambition make use of it. In fine, credit is the wealth of nations. Credit made Venice rich, Genoa rich, the Hans-towns and Amsterdam rich—not credit alone, but credit combined with transactions favoured by foreign commerce. They were not rich in specie, but in general credit, and every man's credit was afloat in the market for what he was in the habit of paying, or what he was presumed to be able to pay, by means of his property and his credit. Credit is, in a word, as to wealth, the 10th power of 10,000 men; but, without credit, only as the radix 10,000, or with the meddling of law, but the 10th root of 10,000.

Credit, however, does not make a nation rich, if there are no transactions, and transactions do not make it rich for more than the current ones of the day, if there is no credit. But, if there is a month's credit, running through each month, from month to month, then the current capital is the value of six weeks transactions, and the trading public have, with certain exceptions, the actual use of that amount. Or if, as in England, before the Panic of 1825–6, there was an average six months credit running over the previous six months; then the trading community had, in the main, the use of a capital equal to nine months' transactions, which, at that time, in England, was, at least, from 1200 to 1500 millions sterling.

Before the Panic, the credit of the 850 country bankers averaged 100,000*l*. each, and probably it was used and loaned to that extent, making alone a circulating capital of 85 millions, which the Panic reduced to a fifth, or 17 millions, in a few days.

Credit, therefore, was the wealth of England, not its specie, which, perhaps, has never exceeded 20 millions, though an ignorant minister, in the hearing of the writer, rebutted all representations about the distress of the country, by asserting, that, in 1828, there was as much specie as in 1824. The man was utterly unsuspicious of the nature and value of credit, 9-10ths of which had disappeared.

Many circumstances must concur, to generate that extensive individual confidence and credit from which results public wealth. Political security, domestic peace, and laws which favour, and do not obstruct. Title to credit is, however, an affair of general feeling and faith. It cannot be conferred by any law or any fiat. Probity, punctuality, and presumed resources, are essential, and these must be confirmed by experience. It arises from no confidence in laws, and their terrors to the debtor. Payment, without coercion, is the basis of credit. He who only pays when obliged is never trusted by those who know him.

The value of credit is that which a man who respects his credit finds it expedient to take. It is as his returns in the time. If he return £50,000 in 12 months, and has 12 months credit, it is worth £50,000 to him; or, if £20,000 every 3 months, his credit is worth £20,000. Credit stands, therefore, in place of capital, and for every practical purpose is capital.

The aggregate of all the credits or capitals, therefore, is the capital of the nation, or, in other words, its public wealth. Destroy credit, by reducing the currency, which enabled men to meet their obligations, and you reduce their capitals, and by so much the capital of the country. This was done by the English Parliament, in 1826–7. It destroyed the credit of 20,000 men, whose average credit was £50,000, and stagnated all the public resources.

CREME DE NOYEAU, is made of 1 oz. of bleached bitter almonds, ½ pint of proof spirit, and 4 oz. of sugar, with colouring. Eau de Noyeau is made with peach kernels, and dangerous in quantities, as the source of hydrocyanic or prussic acid. *Or*, per GRAY, In 2 pints of alcohol mix 1 lb. of sugar, and 4 oz. of blanched bitter almonds.—*Or*, In 4 pints of alcohol and 2 of boiling water, mix 24 lbs. of white sugar, 1 dram of each of ginger, of cinnamon, and of mace; 2 drs. of alum and of coriander-seed, 4 oz. of bitter almonds, and ½ oz. of linseed.—*Or, (D'orange.)* In 2 galls. of alcohol digest, a fortnight, 36 sliced oranges and 18 lbs. sugar. Add 4 galls. of water, 4 pints of orange flower-water, and 12 drs. of tincture of saffron. *Or, (a la violette.)* In 4 pints of alcohol digest 1 oz. of archil and 2 drs. of Florentine orris-root; strain, and add 4 lbs. of sugar.

CRESS.—Three or four years since some grains of Indian cress were sent from the Isle of France to Paris, and, having multiplied exceedingly, it was tried as salad for the table. It is eminently antiscorbutic and depurative; its leaves are more tender and less acrid than those of other cresses, used as salads; it does not suffer from the hardest winters; and will supply leaves during the winter, and especially in spring.

CRETINISM, is a peculiar enlargement of the thyroid gland, denominated *goître*, and accompanied by mental imbecility.

Cretinism occurs in Carinthia and the Valais, and among a miserable race called *Cagots*, inhabitants of the hollows of the Pyrenees, and in Chinese Tartary. On the first discovery of cretinism, it was ascribed by some to the use of snow-water, and by others to the use of water impregnated with calcareous earth, both which opinions are without foundation. The first is sufficiently disproved by the fact that persons born in places contiguous to the glaciers, and who drink no other water than what flows from the melting of ice and snow, are not subject to this disorder; and, on the contrary, that the disorder is observed in places where snow is unknown. The second is contradicted by the fact, that the common water of Switzerland, instead of being impregnated with calcareous matter, excels that of most other countries in Europe in purity and flavor. M. de Saussure has assigned the real cause of the disease. The valleys of the Alps, he tells us, are surrounded by very high mountains, sheltered from currents of fresh air, and exposed to the direct, and, what is worse, the reflected rays of the sun. They are marshy, and hence the atmosphere is humid, close, and oppressive; and when to these causes we add the meagre, innutritious food of the poor of these districts, their indolence and uncleanliness, with a predisposition to the disease, from a hereditary taint of many generations, we can sufficiently account for the prevalence of cretinism in such places, and for the humiliating character which it assumes. The general symptoms of cretinism are the same as those of rickets; but the disease shows itself earlier, often at birth. The child, if not deformed and diseased at birth, soon becomes so; the body is stinted in its growth, and the organs, physical and mental, in their developement.

CROPS. The causes which give to particular crops the character of being exhausting or ameliorating depend either on their being allowed to mature their seed, on their particular mode of culture, which admits of the tillage of the ground during their growth, or on their yielding manure. Wheat, barley, oats, and rye are exhausting. Turnips, carrots, parsnips, beet, cabbage, and rape, if cultivated for their leaves only, are ameliorating. In the case of the turnip, the mode of cultivation, and the quantity and quality of manure it produces, combine with the other circumstance of its not being allowed to mature its seeds, to render it one of the most ameliorating of all crops. But, if allowed to run to seed, it becomes one of the most exhausting. Potatoes and beans, although allowed to mature their seeds, are considered among ameliorating crops, because they admit of being cultivated at wide intervals, and permit the ground to be tilled completely during their growth. They also yield manure. Clovers, if used for herbage, or cut early for food, are ameliorating. But, if cultivated for seeds, exhausting.

CROCUS MARTIS, or Colcothar, is the reddish oxide of iron used in polishing.

CROTON-OIL, is expressed from the *croton tiglium*, and one of the most valuable of the late additions to the materia medica. It is so strongly purgative that a drop is a dose, and half a drop will sometimes produce a powerful effect. It is also found to produce the same effect when rubbed upon the tongue, or even upon the skin. In good hands it is of great value, as its small bulk and insipid taste render it serviceable in cases in which no common medicine can be used, and its great power makes it operate when other medicines fail. It has been given to the extent of 8 or 10 drops, in a bad case of *ileus*, which it cured without producing any bad symptoms. 10 parts of the shelled seeds yield 6 of the oil. It is very hot in the mouth. The acrid principle is 0·45, and 0·55 is bland oil. Externally it relieves rheumatism. The internal dose is 1 to 5 drops in crumb pills, or in any mucilage. Butter or butter-milk corrects its action.

CROUP; a disease of infants, who are suddenly seized with a difficulty of breathing and a croaking noise. It is an inflammation of the mucous membrane of the windpipe, inducing the secretion of a very tenacious, coagulable lymph, which lines the air passages and impedes respiration. The croup does not appear to be contagious, but it sometimes prevails epidemically. It seems, however, peculiar to some families. It has never been known to attack a person arrived at the age of puberty. Cold seems to be the general cause, and therefore it occurs more frequently in the winter and spring. Some days previous to an attack of the disease, the child appears drowsy, inactive, and fretful; the eyes are somewhat suffused and heavy; and there is a cough, which, from the first, has a peculiarly shrill sound; this, in the course of two days, becomes more violent and troublesome, and more shrill. As the disease advances, a constant difficulty of breathing prevails, and the head is thrown back in attempting to escape suffocation. There is not only an unusual sound produced by the cough, but respiration is performed with a hissing noise, as if the windpipe was closed up by some slight, spongy substance. The croup frequently proves fatal by suffocation, induced either by spasm affecting the glottis, or by a quantity of matter blocking up the air passages; but when it terminates in health, it is by a free expectoration of the matter exuding from the trachea, or of the crusts formed there. Dissections of children, who have died of the croup, have mostly shown a preternatural membrane, lining the internal surface of the upper part of the trachea, which may always be easily separated from the proper membrane. There is likewise usually found a good deal of mucus, with a mixture of pus, in the wind-pipe and its ramifications. It will commonly be proper, where the patient is not very young, to begin by taking blood from the arm or the jugular vein, and several leeches should be applied along the fore part of the neck. It will then be right to give a nauseating emetic, ipecacuanha with tartarized antimony, or with squill, in divided doses, and this may be followed up by cathartics, diaphoretics, digitalis, &c. Large blisters ought to be applied near the affected part, and a discharge kept up by savin cerate, or other stimulant dressing. Mercury, carried speedily to salivation, has in several instances arrested the progress of the disease, when it appeared proceeding to a fatal termination. As the inflammation is declining, it is very important that free expectoration should take place, and this may be promoted by nauseating medicines, by inhaling steam, and by stimulating gargles, for which the decoction of seneka is particularly recommended. Where there is much wheezing, an occasional emetic may relieve the patient considerably, and, under symptoms of threatening suffocation, the operation of bronchotomy has sometimes saved life.—*Cyclo. Prac. Medicine.*

Croup may be checked by the external application to the throat of equal parts of camphor, spirits of wine, and hartshorn, well mixed together.

CROW SILK, (*Hairy river-weed*,) is a green fibrous plant, found in stagnant water, used as a vermifuge by country people; with difficulty burnt; adheres firmly to glass or paper, and was used, constantly moist, by the ancients to bind up broken limbs.

CRUCIBLES, are mere open cups, like tumblers, or drinking-horns, made of fine clay, or Hessian ware, so as to stand great heat.

A crucible, or blue pot, may be made into a furnace. One 12 inches high, and 7 wide, with 12 or 15 holes bored and rasped in its sides, should be strengthened with wire, and be furnished with wire handles. A grate should be dropt into it to fit above some of the holes for an ash pit, and a grate larger or smaller enlarges or reduces the ash pit, and varies the fire. Round earthen stoppers for the holes will also vary it, and a wide funnel placed over it will increase the heat so as to raise large crucibles to a white heat. They may be raised by broad rings, and have been covered in.

M. Deyuek has manufactured crucibles surpassing even those from Saxony in their infusibility. Two and a half pounds of pure iron have been fused in one at once, without the crucible suffering any injury.

CRUCIFERÆ, contains nitrogen, easily putrify, and, by distillation, supply ammonia. They are stimulant, but, dried, lose their antiscorbutic quality; the seeds also lose their vitality, unless kept cool. The genus includes mustards, horse-radish, turnips, &c. &c.

CRYSTALLIZATION can only be effected when there is access of air, for the evaporation of the aqueous parts is thereby promoted, while the atmospheric pressure simultaneously packs the atoms according to their fitting forms. It is also facilitated by light, so much that the light side of a jar will be entirely crystallized, and the dark side not at all.

When a solid is dissolved and equally diffused in water, on the water being gradually evaporated, the particles of the solid approach, and finally range themselves in definite forms or crystals, governed evidently by the forms of the atoms, and atmosperic pressure.

Some vapours pass at once to crystals. Other bodies pass into crystals, from liquid solution or melting, by repose and management. They may be enlarged by turning, and by changing their place in the solution.

The crystallization is accelerated by any solid body, as a stick, or rod, or string, which becomes covered with crystals, often very beautiful. The crystals of the very same substances are always of the same forms, but slight differences produce great varieties.

If a liquid be poured on a solid, the motion of the liquid is often sufficiently powerful to overcome the cohesion of the solid: and its particles are consequently disunited, to combine with those of the liquid. This forms the chemical process of *solution*. A similar effect is sometimes produced by the action of an aeriform body.

When these powers are withdrawn, cohesion resumes its force, but with results which are different, according to the circumstances.

When the re-aggregation is sudden, the particles are re-united indiscriminately, and according to no law. But if the force of cohesion is restored more slowly, the particles unite, not indiscriminately, but with regularity, so as to form masses of regular structure and figure, bounded by plane surfaces and determinate angles. This forms the operation of *crystallization*.

Ice is an example, which shoots in long, slender crystals, when water is cooled to a sufficient extent; and salts, which, when they have been dissolved in water, separate in crystals, on withdrawing a part of their water by evaporation, or reducing its solvent power by a diminution of its temperature, is an example of crystallization from fluidity, produced by affinity. In either of these cases, if the operation is conducted slowly, so as to admit of the particles uniting by those faces *most disposed to union*, crystals are formed; and these are, in general, larger, more transparent, and more regular in their form, the slower the crystallization has taken place. The access of air and light exerts an important influence, also, on the crystallization of certain salts.

An enlargement of volume is often produced by crystallization, as in the examples of ice, of several metals, and of a number of salts; while, in other cases, the reverse is the case, the volume of the crystallized substance being less than while it existed in the liquid state—differences evidently depending on the mode in which the particles unite.

Crystals formed from a watery solution generally retain a portion of water in a combined state; and this is the case not only with those salts which are formed by the chemist, and in the arts, but with nearly all of the earthy and saline crystals found in nature. This water is named their *water of crystallization*. When deprived of it, they lose their transparency and density. Some part with it from mere exposure to the air, and suffer these changes; they are then said to *effloresce*. If they combine water and become humid, they are said to *deliquesce*. In some salts, the water of crystallization is in such large quantity, that, on the application of a moderate heat, it causes them to melt—a change called the *watery fusion*.

Water, which has dissolved one salt to the point of saturation, will still take up a considerable proportion of a second, and even of a third. Sea-water contains several well-known saline compounds. In such cases, as the salts have different degrees of solubility, they may often be obtained separately, by a gradual evaporation of the water, the least soluble being the first to separate. The water of the ocean, evaporated to a certain degree, yields common salt; evaporated still further, it deposits Glauber's salts, and the remaining liquid holds dissolved a compound containing magnesia.

Crystallization also takes place in the transition from the aerial form, as is well exemplified in the arrangement of flakes of snow.

Every substance in crystallizing is disposed to assume a certain regular figure: sea-salt, for example, takes the form of the cube; nitre, that of a prism. Carbonate of lime is found crystallized in rhomboids, a particular class of prisms and pyramids; and garnet, in regular dode-caedrons. The form of the crystal, in mineralogy, enables us to determine the species to which it belongs. The same is true of pharmaceutical preparations; their crystalline forms furnish a certain test of the nature of the crystallized body.

It may be conceived that the particles of bodies are of different *regular* figures, and that, in uniting, they are disposed to approach by certain sides, in preference to others, probably by those which admit of the most extensive contact. Hence a regular structure and figure, uniform with regard to each substance, is produced.

The diversified figures of crystals may be reduced to others more simple; thus the equilateral, six-sided prisms, and the double six-sided pyramid of calc-spar, or carbonate of lime, may be reduced by successive sections (parallel to *natural* joints in these crystals) to the rhomboid. The figure thus arrived at by mechanical division, and which is supposed to constitute the nucleus of the crystal, is called the *primitive form*. The number of original forms thus obtained, according to Haüy, amounts to 6.

1. The regular tetrahedron.

2. The parallelopipedron, which includes the cube, the rhomboid, and all the solids, which have six faces parallel, two and two.

3. The octohedron, the surfaces of which are triangles, and, according to the species, equilateral, isosceles, or scalene.

4. The hexagonal prism.

5. The dodecahedron, with rhombic faces.

6. The dodecahedron, with triangular faces.

The secondary forms of crystals, or such as are usually exhibited by nature, grow out of the primitive forms. The particles first unite to produce the primitive form, and from this proceeds the secondary form, by the application of successive layers of particles parallel to its faces; which layers are denominated *laminæ of superposition*. The modification of figure is the consequence of the abstraction of one, two, or more rows, or ranges of particles, from the planes or angles of each of these *laminæ*, by which a decreasing series of particles will be formed. Thus, supposing that upon one side of a cube successive layers of cubic particles be placed, and each layer be less, by one range of particles, than the surface upon which it rests, it is obvious that the lines which bound the sides must be continually approaching each other, and that the last layer must consist of a single cube. It follows, then, that a four-sided pyramid will be raised upon one of the surfaces of the cube; and that, if the same thing happen upon the five other sides, the cube must be converted into a dodecahedron, with rhombic faces. The last figure is then *secondary*. Its formation has generally been quoted to illustrate the law of *decrement*, as it has been termed, and it is easy to represent it by models. If, says M. Haüy, for this kind of rude masonry, which, however, has the advantage of speaking to the ey. , we substitute the infinitely delicate architecture of nature, it will be necessary to conceive the nucleus as consisting of an incomparably greater number of imperceptible *moleculæ*, and then the number of *laminæ* of superposition being itself considerably augmented, while their thickness has become imperceptible, the channels which these *laminæ* form at their edges will likewise escape our senses. Hence the surfaces of crystals appear to us planes.

The facts which have been discovered, relative to the laws of *decrement*, are sufficient to prove that an immense variety of crystals may be made to grow out of the combinations of the particles producing the primitive forms; for the decrements may take place on the edges, or parallel with the faces of the primitive forms, on the angles, in which the lines are parallel with the diagonals of the faces, in lines parallel to those which intersect the diagonals and faces, constituting the intermediate *decrements*, or in a mode which combines, more or less, the decrements already mentioned, and which is, therefore, said to be mixed. These primary decrements may also be so modified, as that they shall take place on certain edges, or certain angles only; or in uniform and alternate ranges; or from one edge, or one angle, to another; or, at the same time, on all the edges and all the angles, &c. Nevertheless, such is the variety allied to this simplicity, that, when limited to ordinary decrements, and to form ranges on the edges and angles of a rhomboid, this species of nucleus is susceptible of producing 8,388,640 varieties of distinct forms.

*Water of crystallization*, is that which combines with the crystals in forming; and *mother water* is that which remains when no more crystals can be obtained from a solution.

In *crystallization*, transparency depends on quantity of water absorbed.

CUBES.—A solid has three dimensions, length, breadth, and thickness. Its contents are the superficies into the thickness. A cubic foot is 12 inches every way, *i. e.* $12 \times 12 \times 12 = 1728$ cubic inches, and a cubic yard is $3 \times 3 \times 3 = 27$ cubic feet.

The solid contents of any cubical figure is the product of its length, breadth, and thickness.

The solid contents of a cylinder is the area of the end by the length.

Of a cone the area of the base by one-third of the heighth.

Of a sphere, or globe, is the cube of the diameter, by 0·5236. *Or*, it is the cube of the circumference, by 0·01688.

Of a cask is half the sum of the areas of the bung diameter, and the head diameter in inches nearly, by the clear heighth of the cask in inches, and divide by 277·274 inches for imperial gallons.

Foı any irregular figures, take the mean or average dimensions, or plunge the body in a vessel of water, and measure the bulk by the displacement or bulk of water.

CUBEBS, OR JAVA PEPPER, has been found to cure gonorrhea, by taking a desert spoonful in water, three times a day. It has been long used in Africa and India for this purpose.

CUCURBITS, or mattrasses, are egg or flask shaped, and used for digesting substances over the fire, evaporating, &c.

CUDBEAR, is a prepared dye, of violet, purple, or crimson, the bases of which is the *lichen tartarus*, which grows on Swedish and Scotch rocks.

CUMIN SEEDS, are a Levant product, and warm and bitter in the mouth. They are carminative, and used externally in dispersing swellings.

CUPEL, is a shallow earthen vessel, resembling a cup. It is formed of bone-ashes, and extremely porous. It is used in assays, to separate the precious metals from their alloys. The process of *cupellation* consists in fusing an alloy of a precious metal, with lead in a cupel. The lead is susceptible of oxidation, and it promotes the oxidation of other metals, and vitrifies with their oxides. The foreign metals are thus removed; the vitrified matter is absorbed by the cupel, or, as it collects on the surface is driven off by the blast of the bellows; and the precious metal remains.

CUPOLA, in architecture, a hemispherical roof, often used as the summit of a building. The Italian word *cupola* signifies a hemispherical roof, which covers a circular building, like the Pantheon at Rome, and the round temple at Tivoli. The invention, or at least the first use, of the cupola belongs to the Romans; and it has never been used with greater effect than by them. The greater part of modern cupolas are semi-elliptical, cut through their shortest diameter. The ancients seldom had any other opening than a large circle in the centre, called the *eye* of the cupola; while the moderns elevate lanterns on their top, and perforate them with windows.

CURACOA.—In 1 gallon of molasses for fourteen days steep 1 pound of dried Seville orange-peel powder, strain, and add 1 gallon of simple syrup.

CURRANTS, *(Ribes,)* red, are acid and cooling. The juice, with sugar, drank as lemonade or orgeat; and is made into excellent wine. *White currants* are a variety, and the fruit less acid. *Black currants (Ribes nigrum,)* leaves, in infusion, are aperitive, diuretic, and used in gargles. The young leaves are substituted for tea. The fruit is aperitive, and used in calculus affections. The juice boiled is made into wine.

*Currant-jelly.*—In 6 oz. of sugar boil 1 lb. of red currant juice. *Or*, equal weights of juice and sugar, boil gently and smoothly three hours; decant, and in three days the whole will be a firm rich jelly.

The dried currants of the shops are a small kind of grape, which grow in the Ionian islands, and used in such quantities that 120,000 cwt. are imported into England annually. They are aperient, and much used in plumb-puddings, mince-pies, &c.

CURRENCY, is the representative of some value, as established by law, or the convention of society. It may be gold, silver, or copper, of the intrinsic worth for which it passes, or it may be authentic paper of a value guaranteed by issuers responsible for the value. As governments usually take the coinage into their own hands, there ought never to exist any currency but such as the government can answer for, and therefore governments are bound to take security of all issuers of notes, which serve as currency, since those among whom they circulate cannot be fully cognizant of the means of parties.

Paper money becomes necessary in a country when the financial operations of the government absorb the specie, and render it impracticable to continue transactions, and meet obligations made before the absorption. By increasing the amount, paper lessens the value, while, adding to numerical obligations, it becomes difficult to withdraw it, even after the government cease to absorb.

Before the creation of the public debt, the currency in England, almost entirely specie, was but 10 or 12 millions, and this, turned once a week, made the national returns, per annum, about 500 or 600 millions, which at a profit of 10 per cent. produced an income of 50 or 60 millions, with taxes of 3 or 4, or one-fifteenth.

But, the addition of 40 millions of paper to 10 millions of specie, turned twice a week, from 1792 to 1825, augmented the national returns to 5000 millions, at only 5 per cent. profit, or 250 millions, with taxes of 60, or about one-fourth.

In this situation of trade and obligations, the government suddenly reduced the currency to 30 millions, and the returns to less than 3000 millions, while the obligations for 5000 existed; and they thereby produced universal confusion and ruin.

For, in trade, if a man cannot pay, when due, 20*s.* but only 19*s* in the pound, he is deemed insolvent, and the law permits the smallest creditor to insist on 20*s.*, or gives him the power of driving the debtor to bankruptcy; and though some were able to meet their engagements in full, yet the mass lost their credit, and under various circumstances became insolvent. They were the *elite* of the system—those who, by enterprise, maintained the amount of transactions, and hence the country, at a blow, lost its spirit and energy.

Hence, it appears, that if a country is, by the policy of a government, forced to adopt a paper currency, it cannot be withdrawn, at least not suddenly, without ruin to most of its institutions, for every million of currency represents or upholds 50 or 100 times the amount of credits and transactions, which ramify through the community; while commercial credit is lost, if a farthing less than 20*s*. in the pound is paid, and if the 20*s*. is not paid when due, or when demanded.

Credit on transactions, therefore, is capital, and currency is the means of sustaining it.

The capital crime of the British Government was taking advantage of a panic, or commercial earthquake, and maintaining, by enactments, the capricious effects of that earthquake, as the guide of public policy. Their further crime was the sanctioning ignorant and brutal courts of law in coercive regulations against debtors, who, by a public calamity, had been rendered unable to pay, and passing an insolvent law, to facilitate judgment and execution against parties whose inability arose from no fault of their own. It continued, at the same time, to inforce the payment of 60 millions of rates and taxes, in a period of years in which it was doubtful whether the aggregate profits of the community amounted to as much; so that men lived upon, and paid taxes out of, their capital.

CURRIE POWDER. Mix together 3 oz. of turmeric and of cumin, 1 oz. of Cayenne pepper, 2 oz. of black pepper, 18 oz. of coriander-seed, and 4 drs. of fenugreek-seed.

CURRYING, is the art of dressing hides and skins, &c.; and this is done either upon the flesh or the grain.

In dressing leather for shoes upon the flesh, the first operation is soaking the leather in water until it is thoroughly wet; then the flesh side is shaved on a beam about seven or eight inches broad, with a knife of a peculiar construction, to a proper substance, according to the custom of the country and the uses to which it is to be applied. The knife used for this purpose is of a rectangular form, with two handles, one at each end, and a double edge.

After the leather is properly shaved, it is thrown into the water again, and scoured upon a board or stone, commonly appropriated to that use. Scouring is performed by rubbing the grain or hair side with a piece of pumice-stone, or with some other stone of a good grit. These stones force out of the leather a white substance, called *the bloom*, produced by the oak bark in tanning. The hide or skin is then conveyed to the shade, or drying-place, where the oily substances are applied, termed *stuffing* or *dubbing*. When it is thoroughly dry, an instrument, with teeth on the under-side, called a *graining-board*, is first applied to the flesh-side, which is called *graining*; then to the grain-side, called *bruising*. The whole of this operation is intended to soften the leather to which it is applied.

Whitening, or paring, succeeds, which is performed with a fine edge to the knife already described, and used in taking off the grease from the flesh. It is then boarded up, or grained again, by applying the graining-board first to the grain, and then to the flesh. It is now fit for waxing, which is performed first by coloring. This is effected by rubbing, with a brush dipped in a composition of oil and lamp-black, on the flesh, till it be thoroughly black: it is then sized, called *black-sizing*, with a brush or sponge, dried and tallowed; and, when dry, this sort of leather, called *waxed*, or *black on the flesh*, is curried. The currying leather on the hair or grain side, called *black on the grain*, is the same with currying on the flesh, until we come to the operation of scouring. Then the first black is applied to it while wet; which black is a solution of the sulphate of iron called *copperas*, in fair water, or in the water in which the skins, as they come from the tanner, have been soaked. This is first put upon the grain after it has been rubbed with a stone; then rubbed over with a brush dipped in stale urine; the skin is then stuffed, and, when dry, it is seasoned, that is, rubbed over with a brush dipped in copperas water, on the grain, till it is perfectly black. After this, the grain is raised with a fine graining-board. When it is thoroughly dry, it is whitened, bruised again, and grained in two or three different ways, and, when oiled upon the grain, with a mixture of oil and tallow, it is finished.

CUTLERY, in the general sense, comprises all those articles denominated *edge tools*. It is more particularly confined to the manufacture of knives, forks, scissors, pen-knives, razors, and swords. Damascus was anciently famed for its razors, sabres, and swords. The latter are said to possess all the advantages of flexibility, elasticity, and hardness. These united distinctions are said to have been effected by blending alternate portions of iron and steel in such a manner, that the softness and tenacity of the former could prevent the breaking of the latter. All those articles of cutlery which do not require a fine polish, and are of low price, are made from blistered steel. Those articles which require the edge to possess great tenacity, at the same time that superior hardness is not required, are made from sheer steel. The finer kinds of cutlery are made from steel which has been in a state of fusion, and which is termed *cast steel*, no other kinds being susceptible of a fine polish.

Table-knives are mostly made of sheer steel; forks are made almost altogether by the aid of the stamp and appropriate dies; the prongs only are hardened and tempered. Almost all razors are made of cast steel, the quality of which should be very good, the edge of a razor requiring the combined advantages of great hardness and tenacity. After the razor blade is forged, it is hardened, by gradually heating it to a bright red heat, and plunging it into cold water. It is tempered by heating it afterwards till a brightened part appears of a straw color. Though this is generally performed by placing them upon the open fire, it would be more equally effected by sand, or, what is still better, in hot oil, or fusible mixture, consisting of 8 parts of bismuth, 5 of lead, and 3 of tin; a thermometer being placed in the liquid at the time the razors are immersed, for the purpose of indicating the proper temperature, which is about 500°.

Razors are ground crosswise, upon stones from 4 to 7 inches in diameter, a small stone being necessary to make the sides concave. They are afterwards smoothed and polished. The handles of high-priced razors are made of ivory and tortoise-shell, but in general they are of polished horn, which is preferred on account of its cheapness and durability. The horn is cut into pieces, and placed between two corresponding dies, having a recess of the shape of the handle. The dies are previously heated to about 500° Fahrenheit, and placed with the horn, in a press of such power, that, allowing a man's strength to be 200 pounds, it will be equal to 43,000 pounds. By this process, the horn receives considerable extension. If the horn is not previously black, the handles are dyed black by means of a bath of logwood and green vitriol. The clear horn handles are sometimes stained, so as to imitate the tortoise-shell.

The manufacture of pen-knives is divided into three departments: the first is the forging of the blades, the spring, and the iron scales: the second, the grinding and polishing of the blades; and the third, the handling, which consists in fitting up all the parts, and finishing the knife. The blades are made of the best cast-steel, and hardened and tempered to about the same degree with that of razors. In grinding, they are made a little more concave on one side than the other; in other respects, they are treated in a similar way to razors. The handles are covered with horn, ivory, and sometimes wood: but the most durable covering is stag-horn. The most general fault in penknives is that of being too soft. The temper ought to be not higher than a straw color, as it seldom happens that a penknife is so hard as to snap on the edge.

The beauty and elegance of polished steel is nowhere displayed to more advantage than in the manufacture of the finer kinds of scissors. The steel employed for the more valuable scissors should be cast-steel of the choicest qualities: it must possess hardness and uniformity of texture, for the sake of assuming a fine polish; and great tenacity when hot, for the purpose of forming the bow or ring of the scissors, which requires to be extended from a solid piece, having a hole previously punched through it. It ought also to be very tenacious when cold, to allow that delicacy of form observed in those scissors termed *ladies' scissors*. After the scissors are forged as near to the same size as the eye of the workman can ascertain, they are paired, and the two sides fitted together. The bows and some other parts are filed to their intended form; the blades are also roughly ground, and the two sides properly adjusted to each other, after being bound together with wire, and hardened up to the bows. They are afterwards heated till they become of a purple color, which indicates their proper temper. Almost all the remaining part of the work is performed at the grinding mill, with the stone, the lap, the polisher, and the brush. The very large scissors are partly of iron and partly of steel, the shanks and bows being of the former. These, as well as those all of steel, which are not hardened all over, cannot be polished: an inferior sort of lustre, however, is given to them by means of a burnish of hardened, polished steel, which is very easily distinguished from the real polish by the irregularity of the surface.

In making cutlery in Rodgers', Champion's, Crashaw's, and Peckston's manufactories, at Sheffield, the article is held in the flame till it acquires the exact shade of colour adapted to its purpose, and workmen plume themselves on their skill in this point.

600° dark-blue, is soft for saws.
560 deep-blue, fine saws.
550 bright-blue, for springs.
530 purple, for knives.
510 brown, for axes, &c.
490 light-brown, for scissors, &c.
470 yellow, for pen-knives, &c.
450 straw, for razors, &c.
430 pale-straw, hard, for lancets, &c.

CYANOGEN, is a compound of two volumes of vapour of carbon and one of nitrogen, sp. gr. 1·8055, equiv. 26. It is formed by heating prussiate of mercury in a glass retort. Prussic or hydrocyanic acid is 1 cyanogen and 1 hydrogen, prepared from ferruginous prussiate of potash. It is a frightful poison. Oxymuriatic acid is its best antidote.

CYANIC ACID, and CYANURIC ACIDS, are merely chemical; but fulmine acid is a compound of mercury, nitric acid, and alcohol. Heat produces crystals of fulminating mercury, which is fulminic acid and oxide of mercury. The acids form salts, which fulminate with heat or a blow. It is cyanogen and oxygen. Several compounds of cyanogen are very poisonous, and all very deleterious.

CYANURET OF MERCURY, is made from prussian blue, by digesting dilute muriatic acid, and when washed and dry, boiling it in water with nearly half more of peroxide of mercury. The solution crystallizes in pure cyanuret. The union of oxygen is conspicuous in this base of prussic acid.

Then hydrocyanic, or prussic acid, is equal parts of the cyanuret and muriatic acid (more oxygen) with four times their joint weight of water (more oxygen) distilled to the weight of the water. How can chemists assert that prussic acid contains no oxygen?

CYCLE.—The year contains 52 weeks and 1 day, and leap-year a day more. Consequently, in different years, the same day of the year cannot fall upon the same day of the week; but, as, for example, the year 1814 began with Saturday, 1815 with Sunday, 1816 with Monday; but 1817, because preceded by a leap-year, began, not with Tuesday, but with Wednesday.

If we counted only common years, from seven years to seven years, every year would begin again with the same day of the week as the seventh year before; or, to express the same in other words, after seven years, the dominical letter would return in the same order.

But as every fourth year, instead of a common year, is a leap-year, this can only take place after 4 × 7, or 28 years. Such a period of 28 years is called a *solar cycle*, and serves to show the day of the week falling on the first day of January in every year. For this purpose, it is only requisite to know on what day of the week a particular year began, and then to prepare a table for the first days of the 27 following years.

The *lunar cycle* is a period of 19 years, after which the new moon falls again on the same day of the month. January 2, 1813, there was a new moon; January 2, 1832, there was a new moon again, and on Jan. 2, 1851, there will be another. As the time from one new moon to another, as astronomy teaches, is about 29½ days, a table of the new moons for 19 years may be very easily prepared. This lunar cycle always begins with a year, of which the first new moon falls on the first of January, and this was the case the first year B. C. Divide by 19 the number of the year plus 1, and the remainder will show what year in the lunar period the given year is. The number of the year is called the *golden number*.

CYCLOID, the line described by a moving wheel. Imagine a circle, which is rolled perpendicularly along a straight line, till the point first at rest is brought to rest again, after an entire revolution. The curve thus described by this point is called a cycloid, because every point in the circumference of a revolving wheel describes a similar curve. The circle is called the *generating circle*; the line on which it is described, the *base of the cycloid*. The length of the cycloid is always four times the diameter of the generating circle, and its area three times the area of this circle. Imagine a pendulum, suspended by a thread, in such a way that, in the swinging of the pendulum between two plates, each of which is bent in the form of a cycloid, the thread rolls and unrolls itself. Then the longest vibrations will be performed in the same time as the shortest, producing isochronism.

CYCLOPEAN WORKS, in ancient architecture; masonry performed with huge blocks of stone, much of which is to be seen in Sicily, said, by the ignorant, to be the works of an ancient and fabulous gigantic race of people. But mines and mummies prove that man has always averaged the same size; and the miracles of scientific machinery, and of labour added to labour, are ascribed to giants only by vulgar beholders. Egypt excelled in these combinations, and Sesostris displayed his power and taste at both ends of the Continent, and even in Britain, at Stonehenge, Abury, &c.

CYLINDER; the name of a geometrical solid, formed by two parallel circular surfaces, called the superior base and the inferior base, and a convex surface terminated by them. There is a distinction between rectangular cylinders and oblique cylinders. In the first case, the axis, that is, the straight line joining the centre of the two opposite bases, must be perpendicular; in the second, the axis must form an angle with the inferior base. The solidity of a cylinder is equal to the product of the base by the length. Archimedes found that the solidity of a sphere inscribed in an equilateral cylinder, that is, of a sphere whose diameter is equal to the height, and also to the diameter of the base of the cylinder, is equal to two-thirds of the solidity of the cylinder.

CYPERACEÆ consists of *round-rooted Cyperus*. Roots sweet-scented, heating, dose ½ a grain to 3, equal to the foreign aromatics. The scent is weak when first powdered, but, by keeping, strengthens. *Adru.*—Root aromatic, stimulant, used for Virginia snake-root: the infusion good in vomiting and fluxes. *Rush nut.*—Root eatable, and when roasted makes good coffee. *Bull rush.*—Seed astringent, emmenagogue, diuretic, hypnotic.

CYPRESS, the most durable of all timber, being free from worms. It grows in Greece and Asia Minor.

DAFFY's ELIXIR. *(Dicey's.)* In 6 lbs. of alcohol infuse 8 oz. of stoned sun raisins, and 2 oz. each of liquorice-root, coriander-seeds, carraway-seeds, aniseeds, elecampane, and rasped guaiacum-wood, and 4 oz. of senna leaves. —*Or*, *(Swinton's,)* In 1 gall. of alcohol and 1 of water, infuse 3 lbs. of jalap, 12 oz. of senna leaves, and 4 oz. each of liquorice and elecampane-roots, and of coriander and aniseeds. Daffy's Elixir is, in fact, the compound tincture of senna, with treacle for sugar-candy, and some aniseeds and elecampane-root.

DALBY'S CARMINATIVE.—Mix 4½ drs. of tinc. of opium with 2½ drs. of tinc. of assafœtida, 3 scr. of oil of carraways, 6 scr. of oil of peppermint, 6½ drs. of castor, and 6 drs. of alcohol. Into each phial put 2 drs. of liquid, 1 dr. of calcined magnesia, and fill with simple syrup, spiced with alcohol. *Or*, it is 2 scr. of carbonate of magnesia; 1 minim of oil of peppermint, 2 of nutmeg, 3 of aniseed, 30 of castor, 15 of assafœtida, 5 tincture of opium, 15 spirit of pennyroyal, 30 tincture of cardamoms, and 2 oz. of peppermint water.

DAMASCUS BLADES, for swords, are in great request; and they are said to be perfectly imitated by the incorporation of iron wires, bound closely round a length of steel, and these melted and welded together.

DAMASK; an ingeniously-manufactured stuff, the ground of which is bright and glossy, with vines, flowers, and figures, interwoven. At first, it was made only of silk, but afterwards of linen and woollen, as in damask table-cloths. According to the opinion of some, this kind of weaving was invented by the inhabitants of Damascus, from which it derived its name. The true damasks are of a single color. If they consist of variegated colors, they are called *ras de Sicile.* The gauze damask also belongs to the silk damask. It is very well imitated by the English, at Barnsley. At present, it is made in great quantities in Germany, of three different kinds, Dutch, French, and Italian.

DAMASKEENING, or DAMASKING, is the art of inlaying iron or steel with other metals, especially gold and silver, and is of great antiquity. It is principally used at present for sword-blades, guards, cocks of pistols, &c.

DAMPS are certain deleterious gases, extricated in mines. They are distinguished by the names of *choke-damp* and *fire-damp*.

The former is found in the deepest parts of mines. It extinguishes candles, and often proves fatal, when it has been suffered to accumulate in large quantities. It consists, for the most part, of carbonic acid gas.

The fire-damp, which prevails almost exclusively in coal-mines, is a mixture of light carburetted hydrogen and atmospheric air, which explodes with tremendous violence whenever it comes in contact with flame.

The injuries which formerly occurred so frequently, both to the machinery and the lives of miners, arising from the fire-damp, are now partly obviated by the invention of the *safety-lamp*.

DAMSON CHEESE, *(or other plums.)* Cover the fruit with water, and boil three hours, pour through a coarse sieve; add one-fourth the weight of the pulp of white sugar, and boil till a candy forms on the side of the pan; then pour into tin moulds.

DANDELION, or TARAXACUM, the most common of our field plants, the root of which is a powerful diuretic, and much relied on in dropsy and jaundice. 2 drs. of the sliced root, in 2 pints of water, should be boiled to a pint, and a small tea-cup or wine-glass full may be taken occasionally. Sometimes cream of tartar is added. The root is diuretic, when roasted, and used as coffee. The blanched leaves are used in salads. The inspissated juice and extract much used, or a strong decoction of the roots, 1 to 4 oz. two or three times a day is detergent, aperitive, and deobstruent.

*Extract of Dandelion*, is made by boiling a lb. of root in a gallon of water to half, straining hot, and then evaporating.

DANFORTH'S SPEEDER, in cotton machinery; a roving frame, in which the bobbins are not turned by the rotation of their axis, but by friction applied to their surface by small wooden cylinders, which revolve in contact with them. By this contrivance, the velocity of the surface of the bobbin will always be the same, whatever may be its growth from the accumulation of roving; so that the winding goes on at an equable rate.

DATE, the fruit of a tree of the natural order *palmæ*, of Africa, from Morocco to Egypt, Syria, Persia, the Levant, and India. Dates are sugary, very nourishing, wholesome, and require no preparation; but when dried, and imported into Europe, they are not much esteemed. The best fruits have firm flesh of a yellow colour; and some varieties are very large, succulent, and without stones. The bunches, weighing from 20 to 25 lbs. when of good quality, are sold at from 3*s*. to 4*s*. each. Almost every part of this valuable tree is converted to some use. The wood is very incorruptible, and is used for building. The leaves, after being macerated in water, become supple, and are manufactured into hats, mats, and baskets. The petioles afford fibres from which cordage is made. The nuts, after being burnt, are used in the composition of Indian ink. Palm wine is made from the trunk; and, for this purpose, the leaves are cut off, and a circular incision made a little below the summit of the tree, then a deep vertical fissure, and a vase is placed below to receive the juice. The date-palm is a majestic tree, 60 feet and upwards; the trunk is straight, simple, scaly; elegantly divided by rings, and crowned at the summit by a tuft of very long pendent leaves, 10 or 12 feet long, composed of alternate narrow folioles, folded longitudinally. The fruit is disposed in 10 or 12 very long pendent bunches. When the male plant is in bloom, the pollen is collected and scattered over the female flowers. Each female produces 10 or 12 bunches every year. They attain the age of 200 or 300 years. The pith of the young trees is eaten, as well as the young and tender leaves. A considerable traffic is carried on in these leaves, which, under the name of *palms*, are sent to Italy, for the religious ceremonies of Palm Sunday.

DAY.—One rotation of the earth on its axis. The Jews commence the next day at a certain hour of the evening, and finish it on the next evening at the same hour. Thus their sabbath begins at six on Friday, and is completed at six on Saturday. The Roman Catholic church commences its festivals in the preceding evening. Our civil day commences at 12 o'clock at midnight, and lasts till the same hour of the following night. The astronomical day begins at noon, and is counted up to 24 hours, terminating at the succeeding noon. In parts of Italy and Germany the next day commences about sun-set, and the hours are counted on till the next sun-set. Noon of "Italian hours" at the summer solstice is 16 o'clock, and at the winter solstice 19 o'clock. The English names of the days are derived from the Saxons. The civilized nations of antiquity named them after their planetary arrangement—1, Saturn; 2, Jupiter; 3, Mars; 4, the Sun; 5, Venus; 6, Mercury; 7, the Moon:—

| Latin. | English. | Saxon. |
|---|---|---|
| Dies Saturni | Saturday | Seterne's day. |
| Dies Solis | Sunday | Sun's day. |
| Dies Lunæ | Monday | Moon's day. |
| Dies Martis | Tuesday | Tiw's day. |
| Dies Mercurii | Wednesday | Woden's day. |
| Dies Jovis | Thursday | Thor's day. |
| Dies Veneris | Friday | Friga's day. |

Tiw, Woden, Thor, and Friga, were deities of the Pagan Saxons. Thor was their god of thunder, and Friga was a goddess, the wife of Woden.

DEBT, is an obligation in money, or an anticipation of means of payment at a certain time. By failure of means, arising from improvidence, miscalculation, or misfortune, persons are often unable to pay debts; but whatever the cause, by the laws of England, in practice, no discrimination is made, as to the cause of non-payment, and the unfortunate and blameless debtor is left at the mercy of the disappointed and enraged creditor. In consequence, after the Panic of 1825, the Government allowed 5969 persons to be imprisoned in the London gaols in 1827; and, in 1826, nearly 50,000 were arrested, and the proceedings actually aggravated by new Rules of Court, made by *Lord Tenterden*, then chief-justice. After long struggles with selfish law interests it was settled, in 1828, that no arrest should take place under 20*l*.; but it is the general opinion, that no arrest should take place for any sum, if the debtor surrender his effects, since he is not likely to increase them in a prison. The insolvent law requires a previous imprisonment, just time enough to enable the debtor to make away with all his property.

DECANTING, is pouring off the clear liquor.

DECOCTIONS, are made of roots, barks, &c. by boiling from 2 to 6 drs. in a pint of water; or of herbs or flowers in half a pint. It should be strained while hot and used fresh. The boiling should be gentle, the vessel should be covered, and the substances first bruised.

DECOCTION OF THE WOODS, or compound decoction of guaiacum, the best known tonic and restorative, is made by boiling 3 oz. of rasped guaiacum with 2 or 3 oz. of raisins, according to quality, in a gallon of water, nearly to half; and, towards the end of the boiling, infusing an ounce of sliced sassafras-root and an ounce of bruised stick liquorice. This will make 8 or 9 pints, to be kept in a cool place, and drank at any time, three half pints per day, for a week. Discontinue for three or four days, and then remake and drink, as before. The constitutional effect in every variety of debility is wonderful.

DECREPITATION, or cracking in the fire, arises from the outer parts of the substance expanding before the inner parts. A glass vessel, exposed to sudden heat, breaks from this cause.

DEFLEGMATION, is the depriving of water.

DELCROIX'S POUDRE SUBTIL, for removing the beards of some women, is made of orpiment, quick-lime, and a vegetable powder.

DELIQUESCENCE, is the conversion of a dry salt into a fluid, by the absorption of the aqueous vapour of the atmosphere.

DELIQUESSING, is imbibing moisture from the air.

DELIRIUM, is a diseased state of brain-action, from fever, in which the judgment and will cease to be governed by the senses. It terminates with the fever, but is preceded by visions and spectral appearances, and followed by a sensibility of the perceptions, which makes every noise and degree of light so painful, that the recovery is slow and the mental irritation, from slight causes, excessive.

DELPHINE. — Blanch stavesacre-seeds, beat them to a paste, boil with water, strain, add calcined magnesia, boil for some minutes; filter, wash the sediment with water, and digest in alcohol at 40°; decant; distil off the spirit; the delphine, left, is a white powder. Soluble in alcohol or ether, but scarcely in water.

DEPHLOGISTICATE, is to oxidate; Priestley's name for nitrogen being phlogiston, the alkaline principle, and dephlogiston for oxygen, the acid principle. Guyton Morveau contends, that hydrogen is the alkaline principle, and that nitrogen is a compound of hydrogen and carbon, for which there are many sound reasons.

DERBYSHIRE SPAR, calcareous earth, refined by filtration, and combined with oxygen, as fluoric acid.

DIGESTION, is the exposure of a body to any solvent with heat, and is the act of the stomach, with the addition of its motion, when proper food has been conveyed into it.

DIACHYLON, *(White.)* In a pint of water mix 4 lbs. of olive oil, with $2\frac{1}{4}$ lbs. of litharge *Or, (yellow.)* Mix 3 lbs. of the preceding with 8 oz. of prepared galbanum and 3 oz. of common turpentine and frankincense.

DIALLING, consists in projecting, on a surface, such lines as coincide with the shadow of an index, or gnomon, erected parallel to the earth's axis on the said surface, at intervals that correspond to the different hours of the day. It is necessary, in the construction of a dial, to determine the intersections of the surface on which the dial is to be delineated, by planes, passing through the edge of the gnomon, and situated at equal angular distances from each other: thus, supposing the plane of the dial perpendicular to the gnomon, and also parallel to the equator, the hour-lines of such a dial will be at equal distances from each other; but, in other cases, their distances will be to be determined by a due consideration of the circumstances, aided by scale and compasses.

Dials have been known from the earliest times; but they have lost much of their value, in modern times, by the general introduction of clocks and watches. Horizontal and vertical dials are most commonly used. Suppose 12 planes, making with each other angles of 15°, passing through the axis of the earth and dividing the sphere into 24 equal parts, one of these planes being the meridian of the place of the observer; start from the meridian, and, moving towards the west, number these planes respectively 1, 2, 3, and so on up to 12, which will be the lower meridian of the place; starting from this point, number as before, 1, 2, 3, &c., again to 12, which will now fall on the upper meridian. We shall thus have a series of horary circles, in passing from one of which to the next, the sun will occupy one hour. At noon, he will be on the meridian, which is numbered 12; it is then 12 o'clock; an hour before, he was on the last horary circle preceding (to the east,) numbered 11, and it was 11 o'clock. Twelve hours from the time of passing the upper meridian, he will pass the lower, also numbered 12, and it will be midnight. Suppose, now, an opaque plane, passing through the centre of the earth, and intersected by the 12 planes in as many diverging straight lines, and mark these lines with the numbers belonging to their respective planes. This opaque plane will represent the face of a dial, the straight lines will form the horary lines marked on its surface, and the style will represent the axis of the earth, and will project its shadow successively on each of the hour-lines, the number affixed to which will show the hour of the day; that is, at 10 o'clock the shadow will fall on the line numbered 10, &c. We shall thus have a dial constructed at the centre of the earth; but the radius of the earth, or the distance from its centre to its sur face, is so small, in comparison with the distance of the earth from the sun, that it may be considered as nothing: we may, therefore, transport our central dial to any given place, keeping the style and surface always parallel to the positions in which we supposed them at first, and we shall have a dial for that place. This is the theory of dials. It follows, from this explanation, 1. That a sun-dial, calculated for any given place, will also serve for any other place under the same meridian, provided its position in the latter place be parallel to its position in the former place. 2. The style of a dial is parallel to the axis of the earth; the meridian line is the intersection of the plane of the dial and the meridian of the place; the style is in the meridian, and inclines to the horizon in the same manner as the terrestrial axis, that is, by an angle equal to the latitude of the place. 3. The hour-lines are the intersections of the face of the dial by 12 planes, inclined to each other by an angle of 15°, drawn from the meridian, and passing through the style. If it is required to mark shorter intervals of time, as half hours, it is only necessary to conceive 24 planes, at an angle of $7\frac{1}{2}°$ with each other, and so on for any subdivisions. 4. The hour-lines of a dial drawn on a plane are straight lines, meeting in the centre ef the dial, where the face is penetrated by the style. The forenoon and afternoon hour-lines of the same number are given by the intersection of the same horary plane, on the opposite sides of the style.—*Ency. Americ.*

DIALS, TRANSPARENT.—Church clocks, in London, have dials, made tranparent, and thus fitted to indicate the hours by day and night. The figures denoting the hours are of cast-iron, in bold relief, and the intermediate spaces are of stained glass, behind which lights are introduced. An addition has been made to the clock machinery, by means of which the clock lights itself, as soon as the sun sets, and puts out the lights in the morning, throughout the year. The carburetted hydrogen, which illuminates the dial, is burning at all times, but the consumption, during the day, is comparatively small, as one of the offices of the lever is to open and shut the aperture by the motion of the large wheel. Hence there is no flame during the day, but in the evening the lever opens the aperture to its full size.

DIAMONDS, the hardest and most valuable of all the gems, are of various colours; but the colourless, which is the sort mostly used in the arts, is, when pure, perfectly clear and pellucid, as water. The colourless diamonds are not, however, the most common. The rarest colours are blue, pink, and dark brown; but yellow diamonds, when the colour is equal throughout, are much valued. Pale blue diamonds are also very fine and rare, but deep blue still more rare. The largest diamond hitherto found is in the possession of the rajah of Mattan, in the island of Borneo, where it was found about ninety years since. It weighs 367 carats. It is described as having the shape of an egg, with an indentation near the smaller end. The governor of Batavia tried to purchase it, and offered, in exchange, 150,000 dollars, two large brigs of war, with their guns and ammunition, and other cannon, with powder and shot.

The diamond is the hardest of all known substances. Nothing will scratch it, nor can it be cut but by itself. By cutting it acquires a brilliancy that much augments its price. Their powder is the best for the lapidary and gem engraver, and more economical than any other material for cutting, engraving, and polishing hard stones. Glaziers cut glass with them; and glass-cutters looking-glasses.

The glazier's diamond is set in a steel socket, and attached to a wooden handle about the size of a thick pencil. It is very remarkable, that only the point of a natural crystal can be used; cut or split diamonds scratch, but the glass will not break along the scratch, as it does when a natural crystal is used.

The district, in Brazil, where the Government collects diamonds, extends about 45 miles from north to south, and about 24 from east to west, in the district of Cerro do Frio, which consists of rugged mountains. The first diamonds found here were used by the governor of Villa di Principe as card-counters, and considered by him merely as curious bright crystals. But lines of demarcation are now drawn around it, guarded as strictly as those of an infected city. Every one, on going out, is subjected, with his horses and baggage, to a minute examination, and, in case of suspicion that a diamond has been swallowed, he is detained for 24 hours. The diamond-washing is performed by slaves, who are hired by the Government.

Although the diamond is the hardest of all known substances, yet it may be split by a steel tool, provided a blow be applied; but this requires a perfect knowledge of the structure, as it will only yield in certain directions. This circumstance prevents the workman from forming facettes or planes generally, by the process of splitting; he is, therefore, obliged to resort to the process of abrasion, which is technically called *cutting*. The process of cutting is effected by fixing the diamond to be cut on the end of a stick, or handle, in a small ball of cement, that part which is to be reduced being left to project. Another diamond is also fixed in a similar manner, and the two stones being rubbed against each other with considerable force, they are mutually abraded, flat surfaces, or facettes, being thereby produced. Other facettes are formed by shifting the diamonds into fresh positions in the cement, and when a sufficient number are produced, they are fit for polishing. The stones, when cut, are fixed for polishing by embedding them in soft solder, contained in a small copper cup, the part, or facette, to be polished being left to protrude. A flat circular plate of cast-iron is then charged with the powder produced during the abrasion of the diamonds; and by this means a tool is formed that is capable of producing the exquisite lustre so much admired on a finely-polished gem. Those diamonds that are unfit for working, on account of the imperfection of their lustre or colour, are sold for various purposes, under the name of *bort*. Stones of this kind are frequently broken in a steel mortar, by repeated blows, until they are reduced to a fine powder, which is used to charge metal plates, of various kinds, for the use of jewellers, lapidaries, and others. *Bort*, in this state of preparation, is incapable of polishing any gems; but it is used to produce flat surfaces on rubies and other precious stones. Fine *drills* are made of small splinters of *bort*, which are used for drilling small holes in rubies and other hard stones, for the use of watch-jewellers, gold and silver wire-drawers, and others who require very fine holes drilled in such substances. These drills are also used to pierce holes in china, where rivets are to be inserted; also for piercing holes in artificial enamel teeth, or any vitreous substances, however hard.

It is cut into the *rose* and the *brilliant*. The *rose* diamond is flat underneath, like softer stones, but its upper surface is raised in the form of a dome, and cut into facets. It has commonly six facets in a centre, which are in the shape of triangles united at their summits; their bases abut upon another range of triangles, which are posited in the reversed order to the preceding ones, and their bases are applied against, or in contact with, them; their points forming *feuilletes* or leaves. These last triangles have between them spaces, each of which is finally cut into two facets. By this arrangement the *rose* diamond is cut into 24 facets; and the surface of the stone is divided into two parts, of which the uppermost is termed the crown, and the surrounding part below it the teeth.

The *brilliant* is thinner than the rose diamond; and its thickness is divided into two unequal parts. One-third is reserved for the upper face of the stone, and two-thirds remain to form the lower part of it, which is termed the *culasse*. The table has eight panes; the circumference of it is cut into facets, of which some are triangles and the others lozenges. The culasse is also cut into facets, which are termed *pavillons*. It is important that these pavillons should be placed in the same order as the upper facets; and that they should agree with each other in the most perfect symmetry.

Although the rose-diamond darts a great splendour of light, in proportion as it is more spread than the brilliant; this advantage is caused by the difference in cutting it. It is formed into 32 facets, of different figures, and inclined at different angles, all round the table, upon the upper face of the stone. The culasse is cut into 24 facets, around a small table, which converts the culasse into a truncated pyramid. These 24 facets below, as well as the 32above, are differently inclined, and exhibit different figures. It is, however, essential, that the facets of the upper and lower parts correspond with each other, and that their proportions be so exact as to multiply their reflections and refractions, and so that we shall best perceive the colours of the solar spectrum.

DIARRHŒA, a violent evacuation of the bowels, may be commonly cured, in the first instance, by absolute stillness and abstinence, drinking lukewarm gruel or barley-water, and keeping the extremities warm. When there is much griping, the discharge of irritating matter should be promoted by castor-oil, tincture of rhubarb, rhubarb and magnesia, or salts and senna. Continuance of pain requires a dose of colocynth and calomel, and afterwards excessive evacuation is checked by an opiate and perfect quiet. When the disease is bilious, with pain, bleeding, general and local, is necessary, with small doses of mercury. When the mucous membrane is much inflamed, local bleeding, gum-water, and other dilutent liquids, warm-bath, or fomentations, and diaphoretics, with extreme quiet, are the remedies. In other cases, starch clysters, with laudanum, are useful; and astringents, as tincture of catechu, kino, &c. No food should be allowed but gruel, arrow-root, rice, barley-water and biscuit, or sago and tapioca. In convalescence, lime-water, with gum or milk, and camomile tea, are good beverage.—*Cyclo. Pr. Med.*

DIBBLING AND DRILLING, are means of sowing seed with regularity, instead of scattering, or broad cast.

Dibbling is, in fact, setting, and effected by an iron, which makes two holes, in which seeds are put. Drilling is sowing in rows or furrows. Both are preferable to broad cast, as saving seed and facilitating hoeing, so useful and important to all young plants. Dibbling, drilling, and horse hoeing-machines, are numerous, and some with equal pretensions.

DIET, or the means of restoring the animal frame, under the circumstances of healthy perspiration, in man, at the mean rate of $1\frac{1}{4}$ oz. per hour of alvine; and urinal evacuations and carbon eliminated in respiration, equal together to $4\frac{2}{3}$ oz. per hour, or 7 lbs. per day, is an important consideration. Some regard it as a purely egotistical question, whether men live on flesh or vegetables; but others mix with it moral feelings towards animals. If theory prescribed human flesh, the former party would lie in wait for their brethren; but the latter, regarding the value of life to all that breathe, consider that, even in a balance of argument, feelings of sympathy ought to turn the scale. They also regard the dead carcases of animals as nauseating, and consider that nothing but the disguises of cookery, and of names, could reconcile intellectual persons to a practice for which there is only the example of carnivorous brutes, and a possible occasional necessity. Nature appears to have converted mineral matter into vegetable matter, for the sustenance of the next gradation—animals. We see all the best animal and social qualities in mere vegetable feeders, as strength in the elephant, horse, and camel; swiftness, in the deer and hare; longevity, in the elephant and tortoise; and all the gregarious qualities only in graminivorous animals. Beasts of prey are necessarily solitary and fearful, even of one of another. Physiologists, themselves carnivorous, differ, however, on the subject; but never mingle moral considerations. Though it is known that the Hindoos and working African tribes live wholly on rice, that the Irish and Scotch peasantry subsist on potatoes and oatmeal, and that the labouring poor of all countries live on the food of which an acre yields 100 times more than of flesh, while they enjoy unabated health and long life, yet an endless play of sophistry is maintained, about the alledged necessity of killing and devouring animals. At 12 years of age the Author of this volume was struck with such horror in accidentally seeing the barbarities of a London slaughter-house, that since that hour, he has never eaten anything but vegetables. He persevered, in spite of vulgar forebodings, with unabated vigorous health, and at 66 finds himself more able to undergo any fatigue of mind or body than any other person of his age. He quotes himself, because the case, in so carnivorous a country, is uncommon, especially in the grades of society in which he has been accustomed to live. Bread, potatoes, and farinaceous vegetables, are his standard food, with puddings, pies, and seasonable fruits and vegetables. On principle he does not abstain from any vegetable luxuries, or from fermented liquors, but any indulgence in the latter requires the subsequent correction of carbonate of soda. He is always in better health when water is his sole beverage, and such is the case of all who have imitated his practice.

DIGITALIS, is an elegant road-side umbelliferous flower, in the midland counties, whose leaves, when dried of good colour, are usefully narcotic and diuretic. By analysis, they yield digitaline, by digesting them in ether; then filtering and evaporating, and mixing the hydratid oxide of lead with the aqueous solution. Evaporating again, and digesting in ether, when a final evaporation yields the bitter glutinous substance. In small doses of 1 gr. the powdered leaves diminish the circulation and the pulse in a decided manner, so as to give increased effect to other medicines. Its diuretic effects are highly beneficial in dropsy. It is used also in consumptions, scrofula, and many other diseases.

DIKES, are fissures, which separate masses of strata, either from their drying and contracting, or from some consolidation, beneath which sinks one part, while the other is maintained on its level. They have not always broken perpendicularly, but sometimes are oblique, and their width is from 2 to 10 or 12 feet. In rocky districts, where they have filled themselves with metals by the silent action of electricity, they are called veins; but, in coal districts, where they are filled with clay and rubble, they are called clay-dikes or stone-dikes. When a dike is not accompanied by much sinking of one side, it is called a *hitch*. When there is a mere break, and no sinking, it is called a *trouble*.

DILL-SEEDS, from which dill-water is made for windy colic, in children, are the produce of an annual plant, which, in July, yields the seeds, in the Spanish Peninsula. Dill-water is made by bruising 2 lbs. of the seeds and pouring a gallon of boiling water on them.

DINNER PILLS.—Mix 6 drs. of aloes with 2 drs. of mastich and of red roses, and of syrup of wormwood. But the best dinner-pill is a light supper, or none, and a light breakfast.

DIPPED WARE, is the common

earthenware, whether jugs, bowls, or drinking-cups, with the parts of the outer surface green, brown, or yellow; and ornamental rings or circles round them. These are formed by the following process, in addition to those of the *Thrower* and *Turner*, described under the Article EARTHENWARE :—

For *Brown*, for jug necks. — Take 4 parts of calcined ochre, blue clay, brick clay (yellow,) and Bradwall wood (the fine crimson red,) clay, and 1 part oxide of nickel: mix well, and pass through a 12's lawn.

*Another. Mingled.* — Take 1 lb. of calcined iron scales (from the smithy,) pick, pulverize, sift through hair and coarse lawn, and mix with 1 quart of earthenware slip. *See* CLAYS. *Or*—

Take 1 quart of saturated slip of yellow brick clay, and 2 oz. of fine zaffres.

*Slate colour.*—Take Turner's shavings of earthenware, 11 parts; mix with water till like thick cream; add two parts of ground zaffres.

*Green.*—In 2 quarts of earthenware slip, without flint, mix 1 lb. of zaffre. Calcine, pulverize, sift; and mix 12 oz. of the calx into 1 quart of flinted slip.

*Dark Green.*—Mix $1\frac{1}{2}$ oz. zaffre with 1 pint stone slip.

*Olive Green.*—Mix 3 pints black marl slip (in weight 24 oz. to pint,) with 4 oz. of zaffre.

*Olive Sponge Dip.*—1 quart of yellow slip and 1 oz. of zaffre.

*Blue.*—3 pints of stone slip and $\frac{1}{4}$ oz. pure oxide of cobalt.

The turner having rendered smooth and in shape the outside of the jug, (or other vessel,) it is dipped, or the outside immersed in the mixture, and set to dry, while he proceeds to turn others. The dipped vessel is again filled on the chuck, and the turner *tools* out of the surface the parts which are to appear *white*, when the baking is completed. In some jugs coloured rings appear; formed by the mixture being applied through a quill, from a vessel into which air is blown to force the fluid out.

Other kinds, *Mocha*, *Tortoiseshell*, &c. wares, have their surfaces ornamented by a sponge, or a drop let fall on it, of a mixture of tobacco, infused in stale urine and turpentine; and the ramifications resemble trees, shrubs, &c.

DISPENSATORY, is a book in which all the medicines are registered, that are to be kept in a regular apothecary's shop. Almost every country in Europe, and many large cities, have their own dispensatories, which the apothecaries are bound to follow; and translations of them and commentaries are useful to the public, as Paris's Pharmacologia, Thomson's Pharmacopœia, or Gray's Supplement to the Pharmacopœia.

DISTILLATION, is an art founded upon the different tendencies which bodies have to pass into vapor by heat, and to be condensed again by cold, and is performed in order to separate them from each other. Its use is very important in obtaining spirits, essences, volatile oils, &c.

In malt distillation the wash is put into the still, and the top fixed. Heat then raises it, and boiling, the spirits first pass over in strength and purity; but the heat being continued till the wash boils, the strength diminishes till the hydrometer shews it is as heavy as water. Previously, however, according to proposed strength, a cock at the bottom of the still is opened and the spent wash is let off. A piece of soap is thrown in at the commencement, to form a surface, and prevent boiling over. A second and third distillation completes the process.

The most common method of conducting this process consists in placing the liquid to be distilled in a vessel called a *still*, made of copper, having a moveable head, with a swan-like neck, which is so formed as to fit a coiled tube, packed away in a tub of water constantly kept cold, and which is termed a *refrigeratory*, or worm-tub.

The fire is applied either immediately to the still, or mediately, by means of a water or sand-bath. The liquid to be obtained rises, in vapor, into the head of the still, and, passing down the curved tube, or worm, becomes condensed, and makes its exit in a liquid state. The still should be constructed with a diameter considerably greater than its height, in order to expose a larger surface to the fire; and the tube should not be so narrow as to impede the passage of the vapor into the worm.

A late improvement consists in introducing the spiral tube into the body of a second still, so that the heat from the condensation of the steam, passing through the tube, is applied to the distillation of liquor in the second. The pressure of the atmosphere is removed from the latter, by connecting it with an air-tight receiver, kept cool. The air in this receiver is allowed to escape at the commencement of the operation; its place is occupied by the steam from the liquor, which being condensed, a vacuum is kept up, whence the distillation proceeds, without any further heat being directly applied to the second still. This form of distilling apparatus is called the *double still*.

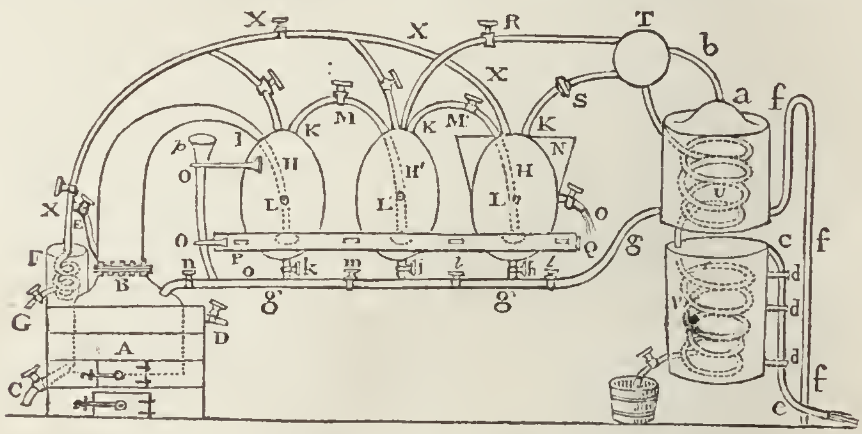
In Booth's great distillery in London, Grimble's very ingenious apparatus produces 3000 gallons per day, of generally-preferred spirit. It differs from all other stills, in having branch-pipes, diverging from the ascending trunk, which conduct the vapour to two or three bundles, or cylinders, of 500 fine tubes each, of half-inch bore, and about five or six feet high. The vapour, in ascending through these, is gradually condensed, and none reaches their upper ends but the rare vapour of pure spirit, the heavier aqueous combination subsiding, and returning at once into the still. The spirituous vapour, which reaches the top of the small tubes, is then passed into a small refrigerator, and runs off as rectified spirit. It is, in fact, a mechanical means of filtering and separating the compound gas, by taking advantage of the various degrees of heat necessary to the condensation of different parts, and the effect is successful and perfect. Mr. Grimble has a patent for this admirable contrivance, which is eagerly adopted, and the cost is very moderate.

As all fluids would become vapours but for the atmospheric pressure, so an increase of the motion or force, by the motion called heat, is necessary to overcome the pressure. This is the principle of distillation. If pressure were less, heat need be less, and the effects of heat be diminished on the substances. Tritton on this principle has produced in the still an approximate vacuum, and is thereby enabled to distil in boiling water. Adam and Duportal have connected a series of recipients, so that the vapour condensed in the first is redistilled in the second, and by the second to third and fourth, and a pure and highly-rectified product is the result. These are now the modes adopted, as far as absurd fiscal laws do not interfere with improvements. The series of still and 4-egg shaped recipients may be used, or only 1, at pleasure, by turning off the others. The whole are connected by pipes.

The apparatus for evaporating and distilling *in vacuo* consists of vessels strong enough to bear, when quite empty, the external atmospheric pressure, and therefore they are generally of an arched form. The vacuum is produced and maintained by air-pumps driven by steam-engines or otherwise; or by the direct admission of steam, which, after expelling the air, is itself condensed into water.

In fact, it is the atmospheric pressure which preserves liquidity, in general, from gassification and vapourization; this application is, therefore, scarcely such as merits a patent.

As this apparatus is most ingenious and important, it is illustrated with a cut and description from Sheridan's Treatise on Distillation, a work of rare value to all whom the subject concerns.




*Explanation of the Egg Plate.*

A, is the furnace in which the still B is built; of this the dome, or head, only is to be seen; the punctuated lines indicate the form masked by the building. C is the tube, furnished with a cock, on the outside of the furnace, communicating with the bottom of the still, for the purpose of discharging the alembic and the eggs. The small tube D, also provided with a cock, serves to point out when the still is full within two-thirds of its height. The little tube E, also proceeds from the head of the still with its cock, which communicates with the long tube X X X X, which runs from the last egg, that is to say, from that at the greatest distance from the still, and communicates with the little worm which is plunged in the little tub F, placed under the furnace to prove the vapours contained in each of the distillatory vases. This little worm has the cock G at its lower orifice. H H H, are a series of distillatory vessels, or condensers, in the shape of eggs, solidly fixed up on the timber-work, P Q, and in succession with each other on the side of the still. One side of this timber-work rests upon the furnace, and the other upon the stone-work, which supports the upper tub. Our plate represents only three eggs, though the number may be augmented at pleasure. It was the opinion of M. Adam, that the greater the number of eggs, the better the rectification would be carried on.

The still communicates with the first egg by the tube I, which rises from the centre of the head or dome, and descends to the bottom of the egg, where it enlarges into the form of the rose of a garden watering-pot, pierced with a number of holes. It must be understood that this tube is soldered to the egg at its entrance, to prevent any other issue of the vapours but by the way intended. The first egg communicates with the second, this with the third, and so on to the last, by means of the tube M, which is soldered to the first egg at the point K, and proceeds to the bottom of the following, where it enlarges, in the form of a watering-pot, as in the first.

The last egg is furnished with the cooler, N, by means of which the superior part of the egg, where the vapours are collected, is encircled with water to commence the refrigeration. This cooler is supplied with a cock, O, to let out the water when it gets too warm. Every condenser is furnished with a cock like this; or, otherwise, their upper parts are plunged in the common tub-full of water. This tub, or bag, often made of copper, has the form of a parallelipede. The tube R communicates from the second egg with the worm, which is generally used with two eggs, sufficient to obtain brandy at 18°, when they close the cock M, which communicates with the second and third egg, and they open the cock R to establish the communication with the worm.

The pipe S communicates between the third egg and the worm. When three eggs are used, they operate as we have indicated; they open the cocks M and S, and stop the cock R. The same proceeding is observed when the greatest number of eggs are employed. Each of these has a tube that communicates with the worm, and all these are soldered to the spherical, T, in which the vapours from each egg are deposited, to be conveyed from thence into the worm in the tub U.

U is a tub, hermetically closed, which contains the principal worm; this is full of wine, heated by the passage of the hot vapours from the last; it is also surmounted with the dome a, from whence proceeds the pipe b, that serves to contain the alcoholic vapours that escape from the tube last mentioned, from the vessel T, or from any of the eggs, or the still, to convey them thence into the worm.

V is a large tub, under the first, and which encloses the second worm, but is much longer than the other. It is full of water, always kept cold; but disgorges itself through the pipe c on the outside of the vessel, against which it is supported by the three iron bars d d d.

We have not thought it necessary to represent the stone cavity used as a store-house for the wines designed for distillation, which wines may be raised into the tub, U, by means of a pump, managed by one man; the conducting-pipe of this, marked f f f, discharges itself near the bottom of the tub U.

g g g is the pipe of communication belonging to the still and the eggs; h i k, are cocks to establish or intercept the communication of the eggs with the conducting-pipe g; *l l* m n, are cocks for continuing or interrupting the communication between each egg, and the still to discharge it, or with the condensing vessel for the purpose of filling it; o o o, is the pipe through which the brandy or the feints are conveyed, by means of the tun, *p*, when they wish to charge the still or the eggs. It is soldered to the pipe g, into which it discharges itself, and is consolidated with the rest of the apparatus, by two iron bars, one of which is nailed to the timber-work P Q, whilst the other is attached to the first egg. This pipe is called *corne d'abondance*, or horn of plenty.

All the apparatus of the French distilleries, which have been encouraged by patents, have been constructed according to the principles of this now described, or others analogous to them.

Many of them, it must be allowed, are but modifications of this; others are imitations of Solimani's model; and others, again, imitations of M. Berard's; consequently, all the distilleries that have given up the old processes for the new, have more or less adopted the principles of those chemists to whom we have already referred.

In the working of the still last described, they first close the lower cocks that communicate with the grand tube connected with the eggs. They open those of the conducting tube; then the wine contained in the tun escapes, and settles in the still. During this time a labourer pumps, to replace the wine in the tun that has escaped by the pipe. They know that the still is sufficiently charged when the wine flows through the little cock adapted to it. When the charging is completed, they stop this cock, as well as that belonging to the conducting-pipe nearest the still. They then open the cock that communicates with the first egg, and keep it so till the wine flows through a tube placed nearly at half of the height of the egg, and then close the small pipe and the large cock that communicates with the egg, and that of the conductor. They proceed the same way with the other eggs, excepting the condensers, when there are any, into which they do not put any liquor whatever; but having filled their coolers with water, they close all the lower cocks, and open the upper ones, to afford a free passage to the vapours; and during this time a fire is kindled in the stove. When the wine is sufficiently heated to disengage the alcoholic vapours, they collect these in the vacant part of the cucurbite running through the first tube; these are then carried down to the lower part of the first egg, from whence they issue, through an infinity of small holes. The globules are compelled to traverse the liquid, to ascend to the upper part of the egg; but it is necessary to observe, that the vapours that issue from the still are not purely alcoholic, but mixed with many watery particles. In visiting the vacant part of the egg, the watery part mixes with the wines, with which it has much affinity, whilst the spirituous parts, accumulating in the upper part of the first egg, pass from that into the second and third, and, after having traversed them all, settle in the upper worm, where they condense, and finish the cooling in the second worm. The liquor comes out cold from the lower orifice of the second worm, and is received into the vessel destined to that purpose. The vapours are passed through all the condensers, or only a part of them, accordingly as the operator wishes to have the alcohol more or less pure.

In order that the alcohol should not evaporate in passing from the worm into the hogshead, &c., and that the stream of the liquor may be seen at the same time, a pipe is attached to the extremity of the worm, communicating with the bung-hole of the hogshead. The terminating part of this pipe is formed of glass, through which the liquid may be distinctly seen. This instrument is called the *lantern*.

The alcoholic vapour that passes into the first egg in a state of ebullition, and deposits a part of its caloric there, contributes to the ebullition of the wine in this vessel, and disposes the liquor to distillation; still the wine is not carried to that degree of heat necessary for this operation, till a considerable time after the distillation has commenced from the still. It is then less pure than when it was first put in; it is charged with watery vapours that have not been able to combine with it. Two different products are then drawn up to the superior part of the first egg; that is to say, the brandy that came out of the still, but disengaged from its watery parts, and the brandy produced from the liquor of the first egg. This being charged with more water than the first, weakens the first liquor; and nothing is obtained from this mixture beyond a brandy of 14° or 16°.

In the passage of the liquor into the second egg, the same phenomenon takes place; but here the aqueous vapours mingle with the wine; and the alcoholic vapours rise from the second egg with a less quantity of water than those of the first, and the brandy flows at 18°.

When it is the object to extract brandy only at Holland proof, or 18°, the still and two eggs are sufficient. The cock which transfers the vapours of the second egg to the third, is then closed, and that which communicates the vapours of the second egg to the highest worm, or the first worm, is then opened. The products of the still are still taken, till it is perceived that the liquor is diminished in strength. The first hogshead is then removed, and replaced with another, to receive what are called the *repasses*, or feints, in order to redistil them, and continue the operation till the still no longer yields any spirit.

To know the precise moment when the distillation should be stopped, they open the first small cock on the side, which conducts to the little worm placed upon the stove, and close that which conveys the vapours from the still into the first egg. The vapours being condensed in the small worm, the liquor is received in a glass: being thrown upon the head of the still, a piece of paper may be lighted by this hot liquor, which, if it does not burn, it is thought proper that the distillation should be stopped. French distillers use the same process, in order to judge of the strength of the vapours disengaged from the eggs employed. When these, which proceed from the still, no longer contain any alcohol, the fire is extinguished, and they let out the residuum, which is become useless; and afterwards do the same with respect to the eggs. But if, on the contrary, alcohol is still found, it is passed from the egg into the cucurbite, which is charged as at first, and they finish at a convenient time, by adding the feints, or some wine, if it should be necessary. The eggs are then charged with the wine found in the first worm, which has already been heated in the first distillation; this is a great saving of fuel, and hastens the operation.

In small distilleries, where only three eggs are used, when they would charge the eggs or the alembic with brandy or feints, they may distil three-six, by charging one or two eggs, or the alembic with brandy, or with the feints. They use a large tube, which, being fixed between the still and the first egg, communicates with another, used to charge the alembic with wine; a funnel is introduced into the orifice of this tube, and by this means, and by closing the communication with all the rest, the liquor is conveyed into the vessel intended, and the cocks are also closed. The large tube here alluded to, is the *corne d' abondance*, or horn of plenty.

Another point is very essential to be attended to: it has been said, that the tun filled with wine, in which the first worm is placed, was hermetically closed; but, notwithstanding this, it receives the alcoholic vapours, whilst very warm, and the wine is heated by them, and consequently, as well as the eggs, disengaged from those vapours. To retain them, the tun is completely covered; but, in order that they may not force the cover, and thus cause the loss of the goods, the cover is made in the shape of a dome, surmounted by a small tube, which either conducts them into the worm, or into the eggs, or the still. Observing these precautions, no loss can attend the process of distillation.

In describing the stills of this country, it is necessary to observe, that all distillatory vessels are either *alembics* or *retorts*; the former consists of an inferior vessel, called a *cucurbite*, designed to contain the matter to be examined, and having an upper part fixed to it, called the *capital*, or head. In this last, the vapours are condensed by the contact of the surrounding air, or, in other cases, by the assistance of cold water, enclosing the head in a vessel, called the *refrigeratory*, or cooler. From the lower part of the *capital*, or *still-head*, a tube proceeds, called the nose, nosel, beak, or spout, through which the vapours, after condensation, are made to flow into a vessel called the *receiver*, which has usually been spherical. Receivers have had several names, according to their figure, being called matrasses, balloons, &c. Retorts, as before observed, are a kind of bottle, formed of glass, earthenware, or metal, the bottom spherical, and the upper part gradually diminishing into a neck, which is turned on one side. This machinery has been generally known by the name of *Woulfe's apparatus*. Something of the same kind, however, was invented by Glauber, as early as the year 1655; but the chief improvement upon Woulfe's apparatus consists in filling the lateral vessels with water, into which the inventor dips the extremity of each tube, bringing into it the uncondensed part of the vapour, and saving a vast quantity of product that had formerly been wasted.

There have been various modes of applying heat in distillation, depending upon the nature of the apparatus employed, as well as upon the substance to be distilled. The common still being formed of metal, is immediately exposed to the naked fire, since, from its tenacity, and its property of conducting heat with facility, it is not liable to crack, which is not the case with glass or earthenware. The still is heated various ways, the most common of which has been by the *sand-bath*, a vessel of iron filled with fine dry sand. The retort, or other vessel, is imbedded in the sand, previous to the application of the fire: the inferior conducting power of the sand does not allow the heat to approach the retort, but in that gradual way that ensures its safety from cracking, and thus the heat is more uniform.

*Sheridan.*

The well-known fact that liquids made to boil at lower degrees of heat *when the atmospheric pressure is lessened or removed*, has recently been applied to some very useful purposes.

Thus the process for refining sugar is, to dissolve impure sugar in water, and, after clarifyng the solution, to boil off or evaporate the water again, that the dry crystallized mass may remain. Formerly this evaporation was performed under the atmospheric pressure, and a heat of 218° or 220° was required to make the syrup boil; by which degree of heat, however, a portion of the sugar was discoloured and spoiled, and the whole product was deteriorated. It occurred to Mr. Howard, that the water of this as well as all compounds might be dissipated by boiling the syrup in a vacuum or place from which air was excluded, and therefore at a low temperature. This was done accordingly; and the syrup, during the process, is not more heated than it would be in a vessel merely exposed to a summer sun, while the evaporation is complete.

The process introduced for preparing vegetable extracts and inspissated juices, by evaporation *in vacuo*, is of a somewhat similar nature. The apparatus consists of a hemispherical still, made of cast-iron, and polished within. It is closed by an air-tight, flat cover, through which rises a wide tube, which is then bent downwards, and terminates in a large copper globe, of a capacity three or four times greater than that of the still. In this tube there is a stop-cock, between the still and the globe.

When evaporation is to be performed, the vegetable juice or infusion is poured into the polished iron still, through an opening, which is then closed, made air-tight, and covered with water. In order to produce a vacuum, the connexion between the still and copper receiver is interrupted, by shutting the stop-cock, and steam from a boiler is introduced by a pipe into the latter, till the whole of the air is expelled from it. This takes usually about five minutes, and is known by the steam issuing from the globe uncondensed. The copper sphere is then closed, and the communication restored between it and the still, by opening the stop-cock, when the greater part of the air in the latter rushes into the former. The stop-cock is again closed, and the globe again filled with steam as before. By the condensation of this steam a vacuum is again produced, which, on opening the stop-cock, extracts the greater portion of the air remaining in the still: in short, by repeating these exhaustions five or six times, an almost perfect vacuum is obtained, both in the still and receiver. Heat is then applied to the water bath, in which the still is placed, until the juice within begins to boil, which is ascertained by inspection through a piece of thick glass, fixed firmly in the upper part of the apparatus. As, in a vacuum, fluids boil nearly 124 degrees below their usual boiling temperature, water passes into ebullition, in such circumstances, at 90° Fahr., or a little above it; and it is never found necessary to heat the juice above a temperature of 100°. The evaporation is continued till the fluid is inspissated to the proper extent, which is judged of by its appearance through the glass.

Extracts prepared in this way are found to be greatly preferable to those obtained by evaporation at a high temperature: they are considerably stronger, as the active principles in the juices are not decomposed by reaction between their elements, favoured by heat; and they are free from all burnt flavour, or empyreuma. There are many operations, however, in which liquids are employed, that would corrode metallic vessels: in such cases, vessels are employed, constructed either of glass, platinum, or stone ware.

In the preparation of many medicinal substances, the process of boiling *in vacuo* is equally important. Many extracts from vegetables have their virtues impaired, or even destroyed, by a distilling heat of 212°; but, when the water used in making the extract is evaporated *in vacuo*, the temperature need never be higher than blood-heat, and all the active quality of the plant remains in the extract.

The influence on the human system of vegetable medicines thus obtained, is so different from that of the old preparations, that every practitioner ought carefully to advert to the circumstance of preparation.

*Distilled Waters* are intended as vehicles for medical purposes, and some for perfumes. The herb as collected, decayed parts separated, and dirt, &c. removed, is added to water, and distilled with care. For perfumes, the herb, &c. must be carefully picked, and the waters distilled in a high narrow-necked still, and if a superior article is required, the waters must be redistilled by a gentle heat. If they have acquired a burnt smell, freezing will remove it. They should be kept in a cool place and covered with paper, pricked with pin-holes, for three or four months. Acidity may be prevented by adding calcined magnesia, and they may be recovered by adding to each gallon 8 grs. of borax and of alum.

Rectifiers receive malt spirits from distillers from proof to 25 per cent. Their business is to re-distil once, for rectification. Then to distil again with various vegetable and chemical substances, so as to produce flavours called gin, hollands, brandy, peppermint, and other cordials. For gin, Italian and German juniper-berries, and coriander-seeds. Hollands are made from rye-spirit, flavoured with juniper and other ingredients.—*See* Brandy, &c. In rectifying spirits for gin, proof is reduced to 17 and 22 per cent. under proof, and at that strength sold to the dealers.

In the trade of spirits, there is the distiller, who makes the spirit from the fermented grain and wash; the rectifier, who concentrates, compounds, and flavours it; the merchant-dealer; and the retailer, in the gin-shop and public-house.

To determine the probable produce of wines, &c. intended for distillation, a small alembic has been invented at Paris, adapted to heating with spirits of wine, and a glass vessel used as a recipient, so that a single glass of wine may be distilled. It was adopted as a toy, and became the means by which families made all kinds of flavoured waters. The leaves of oranges, roses, &c. &c. were laid on gratings above the water, and the vapour rising through them received their odour and flavour. The whole weighs but 5 or 6 lbs. and is in a box but 16 inches long and 3 or 4 square.

The excise laws, in our tax-ridden country, enact that duty must be paid on 19 gallons of spirits for every 100 of wash, this being the maximum. Hence the average gravity aided by *lob* is from 100 to 120 lbs. of saccharine matter per barrel. The charge of a *wash* still is from 16 to 20,000 gallons, and the *low-wines* still is the produce of the wash still, and from this are produced *spirits* and *feints* in separate vessels. The feints are turned into the next wash still. The spirits are then sold to rectifiers, who re-distill, flavour, and prepare for consumption.

A liquid obtained by distillation is sometimes not perfectly pure, or it is dilute, from the intermixture of water, that has been elevated in vapor along with it. By repeating the distillation of it a second or a third time, it is rendered more pure and strong. This latter process is named *rectification*, or sometimes *concentration*.

DEAF AND DUMB.—Deafness occurs, in every degree, from that which merely impairs the accuracy of the ear, in distinguishing faint or similar sounds, to that state in which there is no more sensation in this organ than in any other; and sound is felt, in almost every part of the body, as a mere vibration. Articulation is acquired by imitating the sounds which we hear uttered by others, and correcting the voice, by means of the ear, until the imitation is precise. Deafness, therefore, in every degree, affects the distinctness of articulation, and, if it is so great that the subject can no longer distinguish between articulate sounds, he is incapable of acquiring speech, in the ordinary manner.

The immediate causes of ordinary deafness arise from obstructions in the external or internal passage of the ear, and cures have sometimes been effected by removing these obstructions by means of instruments or injections. Perforation of the tympanum is sometimes useful in rendering it more easy to remove obstructions which may be discovered; and, for this purpose, it is deemed important to perform it by means of circular discs, closing with a spring, which remove a portion of the membrane, and leave a permanent opening. In 81 cases of perforation at Groningen, only three were permanently relieved, and these in a very partial degree.

When a number of deaf mutes are brought together in a single institution, selections and combinations of their various dialects are formed; the best are gradually adopted by all; and a new and more complete form of the language is the result—as in nations collected by civilization. This process, carried on for half a century in the institution of Paris, and some others in Europe, under the observation and direction of intelligent men possessed of hearing, has produced a language capable of expressing all the ideas we convey by articulate sounds with clearness, though not always with equal brevity, and which those who value it least admit to surpass speech in the force with which it communicates the feelings and states of mind.

This language, in its elements, is to be found among all nations, and has ever been the medium of communication between voyagers and the natives of newly-discovered countries. It is employed by many savage tribes to supply the paucity of expression in their language, or to communicate with other tribes. Among the Indians of the western territory of the United States, Major Long found it an organized language, employed between tribes who spoke different articulate languages. The accounts received from himself, as well as his work, show that it corresponds almost precisely with that in use in the school of Paris.

DIURETICS, are a class of medicines which in various ways act on the urinary secretions and evacuations. Paris divides them into eight classes. Those which undergo no decomposition, as potassa, oil of turpentine, juniper berries, and cantharides; those which undergo decomposition, as acetate and super-tartrate of potassa, squill-root, meadow saffron, capivi balsam, and tops of broom. To which he adds, as producing mixed action, mercury, digitalis, &c. &c.

DIURETIC PILLS. (1 *twice daily*,) Mix 4 grs. of squill root, 10 grs. of foxglove leaves, 6 grs. of calomel, 1 scr. of myrrh, half a dram of assafœtida, with extract of gentian, into 15 pills.

DIXON'S ANTIBILIOUS PILLS, are equal quantities of aloes, scammony, rhubarb, and emetic tartar.

DIVIDING MACHINE. The Society of Arts lately awarded their Gold Isis Medal to Mr. Andrew Ross, for improvements in the Dividing Machine. Mr. Ross first divides his circle into forty-eight parts, by continued bi or tri sections, or by a combination of each method. The points thus formed being carefully marked on the limb of the circle, the intervals are then subdivided in the following manner:—An arc, equal to one of the spaces to be subdivided, is procured, and is divided correctly, and to the same degree of minuteness, as it is intended to divide the plate of the engine. The radius of this arc is to be equal to that of the engine; and whatever errors there may be in its original divisions, are corrected by the following process:—A second arc, having an angular value equal to the first, with a radius only one-half or one-fourth as great, is, together with the first, attached and made concentric with the plate of the engine. The divisions of the first are transferred by means of radial lines to the second, the spaces between them being diminished, of course, in proportion to the radii of the respective arcs. When the second arc has received a counterpart of the divisions of the first, it is placed on the circumference of the engine plate, and there fixed, so that the divided arc shall occupy exactly its proper angular space on the limb of the plate. The divisions of the second arc are then transferred to the first or larger one, a single interval on this latter comprising two or four on the former, according as the radius of the one is twice or four times as great as that of the other. In this manner, the errors of any particular intervals become gradually distributed among the rest, and, by repeating the process a sufficient number of times, are reduced to invisible quantities. The improvements consist of an apparatus, by which the divisions of the engine-plate, corrected as above described, are transferred to the arc of circles of other instruments.

DOCKS are of four kinds. 1. *Basins*, or docks open to the tide, called dry-docks, because the vessels frequenting them ground at low water, and lie dry on the ebb tide, and float again on the next rise of the tide. They are used at Liverpool as entrances to the wet docks, and are frequented by coasters, and small or light vessels, which do not injure by lying on their sides.—2. *Wet Docks*, in which vessels float and are unloaded close to the wharfs or quays, and in which the water is kept at equal depth by flood-gates. These are vast works at London, Liverpool, &c. &c.—3. *Graving docks*, for repairing of ships, are excavations with flood-gates pointed towards the tide, to keep the water out while ships are under repair. Vessels are admitted at high water; and the gates are shut at low water; and when the repairs are completed, the gates are again opened before the rise of the tide, and the vessel is on the flood hauled out of dock. In some countries, where there is little or no tide, these docks are so constructed as to have the water within forced out by pumps, or other mechanical operations. At Portsmouth, floating gates are constructed, in the form of a vessel, with each end like the bow of a ship, neatly fitted to the lock, and to work up or down a groove in the lock with the tide, by pumping water into, or out of the vessel, sufficient to float or sink it, as occasion requires. 4. *Slips*, for building ships, also are excavations, sloping and inclined towards the tide, well framed and floored with timber, &c. Harbours with docks are now universally preferred for mercantile shipping, owing to the varying heighth of running and tidal waters. Docks are, therefore, made or making at all the commercial ports of the United Kingdom.

DOGWOOD, is a small tree of the United States, from the 43d degree of latitude to Florida, and extending westward beyond the Mississippi. The large white involucres of the dogwood, together with the rose-colored flowers of the Judas-tree make a beautiful appearance in the spring. The dogwood attains the height of 20 or 30 feet, and has a trunk 8 or 10 inches in diameter; the wood is white, hard, of a fine texture, and much esteemed. It is used by cabinet-makers for inlaying, &c. different ornamental works, and for the handles of tools, plane-stocks, &c.; it is considered little inferior to box.

The bark of this tree, as well as that of several other species of *cornus*, possesses similar properties with the Peruvian bark, and is employed successfully in the cure of intermittent fevers. The bark of the root, stem, and branches tastes very much like that famous bark; it is bitter, astringent, and slightly aromatic. Its astringency is, however, stronger than that of the Peruvian bark. Its seeds yield oil, and the wood is used for charcoal of gunpowder.

DOG-ROSE, or *Wild Briar*. The root has been recommended in hydrophobia, and a decoction of it is used in dysentery. The fruit, *hips*, are lithontriptic, and opening. The pulp makes a fine conserve. The excrescences made by an insect are used in calculus diseases. The petals are cathartic.

DOMESTIC ECONOMY. It is the general rule of prudent persons, with fixed incomes, not to spend more than six-twentieths on household expences, three-twentieths in servants and shew, four-twentieths in education of children and personal expences, four-twentieths in rents, furniture, &c. and to reserve three-twentieths every year for contingences. Hence, if a man have 400 or 4,000*l.* per annum, he may expend 120 or 1,200*l.* in articles of consumption, 60 or 600*l.* in servants and display, 80 or 800*l.* on his family and self, 80 or 800*l.* in rent, &c. and reserve 60 or 600*l.* for an accumulation fund. When the income is derived from trade, and its fluctuations, the reserve-fund should be six-twentieths, and be the first object, and the rest be apportioned accordingly; and, in like manner, when it depends on health and personal exertion, for in that case every seventh year generally proves unhealthy or unproductive.

DOMINICAL, or Sunday letter, is one of the first seven letters of the alphabet, set for Sunday, and then the other days follow in the series. It is found by dividing the date with 9 added by 28, and the *remainder* is the number of the Sunday letter. If 1, it is A; if 3, it is C. If no remainder, it is G.

DOSE. Dr. Young directs that doses for children under 12 should be reduced in the proportion of the age, + 12 to the real age. As, for the age of 3, 3 + 12 or 15 to 3, or $\frac{1}{5}$th the dose for an adult; or, at 6, 6 + 12 = 18 to 6, or one third.

DOVER'S POWDER. Into a red-hot iron mortar throw 4 ounces of nitre, and of vitriolated tartar, and stir with a spoon till they cease flaming; pulverize this ferro-alkali, and add 1 ounce of opium, and of roots of liquorice and ipecacuanha.

DRACHM, is 60 grains, by weight of 5760 to the pound, and 8 are an ounce; or, in fluids, it is 60 minims, of which there are 7680 minims in the pint measure, or 128 drachms. It is also the 8th of a fluid ounce, which is 480 minims. In avoirdupois weight, of 7000 grains to the pound, the drachm is 27·34375 grains, or 256 drachms to the pound.

DRAINING, is a trench to various depths, and as narrow as possible. It is kept open by laying twigs, stones, &c. or loose turf, and then filling over; or better by laying in it a long pole with a ring and piece of string, filling in with stiff stuff, and then pulling the pole forward by the string. A free cavity is thus left as water-way.

Plants cannot contend with moisture till they get green leaves, and if there is wet, the land should be water furrowed.—*Young's Calendar.*

March determines the wet and dry parts of a field, and the parts that require boring or drainage.

Instead of ascribing the foulness of our pastures—the lateness and poorness of our crops—the stiffness of our land—the miriness about the farm-yard—the wetness of the land—the coughs and consumptions of the family, to the quantity of rain that falls, let the ground be effectually drained, and the profit will be great to the farmer. Rain will then refresh the fields, but not be left in the furrows.

DRAWING.—When we consider the art of drawing as it exists at the present time, we perceive that the kinds of drawing are three—with the pen, with crayons, and with Indian ink.

Artists sometimes employ coloured and sometimes white paper; in the former case, the lights are produced by white crayons; but, in the latter case, they are produced by leaving the paper uncovered.

The drawings with the pen have always something hard and disagreeable, yet they give steadiness and ease to the hand, and are peculiarly serviceable to landscape painters. There are two different ways of drawing with the pen; either the drawing is darkened on the shaded side with lines, or the outline only is given by the pen, and the shades are delicately touched in with India ink.

The crayon drawings are the most common, and the most suitable for beginners, because any faults can be effaced or covered over. Artists make use of black, as well as of red crayons; and, when the ground is coloured, they produce the light by means of white crayons. If the crayon is scraped, and the powder rubbed in with little rolls of paper or leather, the drawing becomes exceedingly delicate and agreeable.

There is another style of drawing, in which India ink, or sepia and bistre intermingled with carmine and indigo, are used. The lights are produced by leaving the white surface uncovered. This mode produces the finest effect, and is very much used in the representation of all kinds of subjects.

There are various classes of drawings, as sketches, studies, academy figures, cartoons, &c.

The great schools in painting differ quite as much in respect to drawing as in respect to colouring. The style of drawing of the old Italian school is as hard, dry, and meagre as that of the old German school. The defects of the former are more often redeemed by beautiful forms and just proportions, whilst in the latter a meaning is frequently expressed, which inclines more to poetry than to art. At a later period, the Roman school became, in Italy, through the influence of Raphael's exquisite sense of the beautiful and expressive in form, and through the study of the antique, the true model of beautiful drawing. The Florentine school strove to excel the Roman in this respect, and lost, by exaggeration, the superiority which it might, perhaps, otherwise have gained from its anatomical correctness and deep study of the art. The masters of the Florentine school often foreshorten too boldly. In the Lombard school, delicate drawing appears through enchanting colouring; but, perhaps, it is more true to nature and feeling than to scientific rules. The Venetian school, in reference to the other schools of Italy, has many points of resemblance, good and bad, with the Dutch school, in reference to Germany. In the Venetian school, the drawing is often lost in the glow and power of the colouring; and it is very often not the nobleness of the figures and ideas in the drawing, but the richness, boldness, and glowing nature of the painting, which delight us. The French school was, in Poussin's time, very correct in drawing; and he was justly called the *French Raphael.* At a later period, the style of this school became *manièré.* David introduced again a purer taste in drawing, and a deep study of the antique. In Germany, there cannot be said to be any general style of drawing peculiar to her artists. In England, anatomic accuracy is combined with grace and freedom, and it is beyond question the best living school.

*To make a wash to fix chalk and pencil drawings.*—Boil some gum mastic in a tube, stopping the upper end with the finger or otherwise. Dilute it with alcohol till the mastic is to the alcohol as 1 to 40.

A drawing-board is a flat smooth

board, with or without a frame, on or in which drawing paper is fitted, and a T square provided for perpendicular and horizontal lines. It is often used with a case of instruments, when, as in architecture, a scale and mathematical precision are required.

DREDGING, is the removing of mud, silt, and other deposits, from the bottom of harbours, canals, rivers, docks, &c. Every rill of water carries with it a quantity, however minute, of earthy particles, and hence these rills are so many tributaries to the brooks and rivulets falling into the great streams which form the drainage of the vast valleys through which they flow, finally carrying their waters to the sea. The late Mr. Rennie reported that 400,000 tons of mud were annually discharged into the Thames from the sewers of London. The most simple mode of dredging, is the spoon dredging-boat, still used in Holland and Flanders, in deepening the canals. In the Thames, this operation is conducted on a large scale, and the stuff dredged from the bottom, consisting chiefly of gravel, is sold at one shilling a ton, for ballast.

The spoon apparatus consists of a strong ring or hoop of malleable iron, about 6 or 7 feet in circumference, formed for making an impression upon soft and muddy ground. To this ring is strongly attached a large bag of bullock's hide or tanned leather, perforated with a number of small holes, with a capacity of four or five cubic feet. A long pole or handle is attached to the spoon, and a rope to the bottom of the bag, for directing their position at the commencement of each operation. The pole or handle varies in length and thickness, according to the depth of water, from fifteen to thirty feet. This apparatus is generally worked with a wheel and pinion, or winch; and the chain or rope is brought from the spoon to the winch, through a block suspended from a small crane, for bearing the spoon and its contents to the side of the boat. The purchase-rope is led upon deck by a snatch-block in the proper direction for the barrel of the winch. In situations where the command of head-water is considerable, it is retained in a scouring basin, which is a water-tight compartment of a harbour furnished with sluices to run off the water as required.

All harbours left dry every tide at low water, wherein the deposition of mud is most apt to take place, ought, if possible, to be furnished with a scouring basin. For clearing the bottom and bar of a harbour, in conjunction with that mode of dredging which simply loosens the stuff, the use of the scouring basin is most effectual. The most eminent engineers, in accordance with this idea, have introduced scouring basins into their designs of tide-harbours. Of these, the sluices at Ostend and Ramsgate harbours are particular examples, where the silt in the outer harbours is dredged and loosened, and raked into the tracks or courses of the water issuing from the scouring basins. To effect this, the dredging-harrow, consisting of a frame of timber and plate iron, is used. But, in the improvement of navigable rivers, many of these modes of dredging and scouring have been laid aside, and the operation of narrowing the channel and confining the current has been adopted. The bucket dredging machine was first used by the late Mr. Rennie, at Hull, and, whenever a continued necessity exists for dredging, steam apparatus is always employed.

DRINK, IMPERIAL, is made by infusing, in 3 pints of boiling water, half an ounce of cream of tartar, a quarter of a pound of white sugar, and some orange-peel. It is anti-fibrile.

DROP, is a loose measure of medicines, taken as a grain, but varied by the mouth of the vessel and the viscidity of the fluid. 5760 drops ought to be a ℔; 480, an oz.; 60, a dr.; and 20, a scruple.

*Minims* are fluid measures in pharmacy, a dr. being 60; an oz. 480; a pint, 7680; and a gallon, 61440.

DRY-ROT.—It had been found, from long experience, that the water in the reservoirs for supplying the precipitate pits, at the copper-mine works at Pary's mountain, in Anglesea, has the property of preserving timber from decay and dry-rot in a surprising manner, by the short process of steeping it therein a few weeks only, and that it has such a powerful effect in hardening the wood, as to blunt the sharpest tools. It, consequently, is found necessary to shape and fit the wood completely for the use intended, before it is put into this water for seasoning. The water is impregnated with copper, sulphuric, and vitriolic acids. It is preserved in large reservoirs for supplying the precipitate pits, which are filled with old iron, that absorbs the copper from the water. A complete transmutation takes place in the iron; it gradually becomes incrusted with the copper, whilst, at the same time, the acids act as a corrodent; so that a piece of iron thrown in, after a certain time, comes out copper. The present method is to immerse ships and timber in sea-water; but the component parts of sea-water, common salt, marine magnesia, and salenite, are very dissimilar, from those of the mineral waters of Pary's mine.

DUNGHILLS. A writer in a French

agricultural journal points out, with great force, the injury done to the atmosphere, as far as respects the breathing of animals, by the decay of animal and vegetable matter in dung-hills, ditches, ponds, wells, and especially in sewers, and the cess-pools of water-closets. Wherever health is an object, he recommends neutralizing the mephitic exhalations which arise from these places, by daily strewing over them, from a dredgebox, powder of lime, of which a very small quantity is said to have the desired effect.

DUTIES OF CUSTOMS, are established in the ports of all countries as impositions on foreign products for purposes of revenue, and to protect native products and trades. The British customs yield nearly 20 millions of revenue, of which spirits are 3, sugar 5, tobacco 3, wines $1\frac{1}{4}$, corn $\frac{4}{5}$, coffee $\frac{3}{5}$, and timber $\frac{1}{2}$. 20 or 30 articles yield but a few hundreds each, and are a profitless annoyance.

Custom-House dues measure the real wisdom of the commercial policy of governments. They are always a tax on exportation, for they are a tax on the imports, or the returns, which directly or indirectly an exporter obtains for his produce or manufactures. Trade is a balance of accounts, and though exports are not taxed, yet if imports in return are taxed, it is in effect an impost on the first operation. It is assumed that the importer may add the tax to the price, but this often fails; while a small reduction in the current price of a heavily-taxed article includes frequently all the profit of the merchant.

At the same time as exporters receive in exchange such articles as they can obtain, a contention arises between them, and the home-growers or producers, of the same articles, and the balancing of these conflicting interests is the onerous duty of governments. When the articles are such as cannot be produced in our climate, duties of customs are mere fiscal assessments; but when we can grow or make the same articles at home, their importation is injurious to domestic industry, and the importer exposes himself to the reaction of Custom-House duties.

Some anti-national doctrines on this subject have latterly been advanced, and great mischiefs have resulted from them; but, as the system of protecting duties raised Great Britain to its pinnacle of prosperity, and it is the system of the oldest and happiest nations, who permit no foreign article to interfere with domestic ingenuity and produce, we may conclude, that it best accords with national prosperity. We can only open our ports, when other nations do the same; when the necessaries of life are equal in price; and when all trades can be enabled to work for a common fund, rich enough to sustain the fluctuations of particular branches from effects of foreign competition.

DYSENTERY, differs from diarrhœa in the mucous, bloody, and painful character of the stools, and diarrhœa often precedes dysentery. It is accompanied by fever, and all its phenomena of foul tongue, loss of appetite, &c. In tropical climates all the symptoms are greatly aggravated. It differs from cholera in prolonged duration, in the odour of the patient, and in no vomiting. But it often becomes chronic and fatal. The causes are, cold and chill after warmth, or by night, after hot days. Other causes are putrid meats, bad wine, and marshy atmosphere, or malaria. The first remedy is bleeding, general and local, by many leeches, followed by fomentations and warm bathing. If not preceded by diarrhœa, castor-oil, emollient enemas, and calomel with Dover's powder, are useful. After bleeding, laudanum is recommended. The anus should be bathed with Goulard-water, and anointed with wax and oil. The diet farinaceous vegetables, as arrow-root, rice, barley-water, gum-water, &c.—*Brown Cyclo. Pr. Medicine.*

DYEING, consists in fixing upon cloths, of various kinds, any desired colour.

The substances commonly dyed are either *animal*, as *wool*, *silk*, *hair*, *leather*, and skins of all kinds; or *vegetable*, as *cotton*, *flax*, *hemp*, &c. Great differences exist between the affinities for colouring matter possessed by these substances, so that a process which perfectly succeeds in dyeing wool may fail when applied to cotton. Wool has generally the strongest affinity for colour; silk and other animal substances come next; cotton next, and hemp and flax last.

Of the numerous known dyes (says Packer,) few can be applied to either animal or vegetable fibre without some preparation beyond that of cleansing the stuff, and immersing it in the dyeing liquor. When colours can be fixed on cloth without any previous preparation, they are called *substantive* colours, such as *indigo;* when they cannot be so fixed, but require to be saturated with some preparation, such as acetate of alumina, or a metallic oxide, &c. they are called *adjective* colours: of this kind are madder, cochineal, &c. The substances with which cloths are impregnated, previously to being dyed, are called *mordants*, because they are supposed to *bite* or *lay hold* of the colour which is applied.

The dye-house should be spacious according to the quantity of work intended to be done in it; it should be also as near as possible to a clear running stream. The floor should be a mixture of lime and cement, and sufficiently inclining, so that water, the old contents of the vats, &c. &c. may run off freely when thrown down. A dyer cannot be too particular in regard to the water which he uses. To discover whether water contains iron or not, a little tincture of galls or prussiate of potash must be dropped into it; if a purple or blue tinge be produced in the water, we may be assured that it does contain iron. For dyeing delicate colours, the water which ought to be chosen for such purpose, the purest and best, should be heated with bran in a bag, when much of the contents of the water inimical to dyeing will rise to the top in the form of a scum, and should be taken off just before the water boils. Instead of bran, a little alum will answer the same purpose, when it is not inimical to the colour intended to be dyed.

All solutions and decoctions of Brazil wood, logwood, fustic, &c. should always be prepared in the same quantity and proportion, and one measure be invariably set apart for each. A copper, in proportion to the size of the work, should always be used for weld; and as weld will bear boiling and re-boiling, it can be boiled by the half bundle, or more, according as it may be wanted. The most difficult part of dyeing is that of *light drab*, *stone drab*, *&c.*

Wool, in its preparation for dyeing, requires to be cleansed, by scouring, from a fatty substance, called the *yolk*, which is contained in the fleece. This is done by means of a weak alkaline solution, which converts the yolk into soap. Putrid urine is commonly employed, on account of its cheapness; the ammonia it contains being sufficient to remove the grease.

Silk, when taken from the cocoon, is covered with a kind of varnish, which, because it does not easily yield, either to water or alcohol, requires also the aid of a slight portion of alkali. Much care is necessary, however, in this operation, since the silk itself is liable to be corroded and discoloured. Fine soap is commonly used; but the white China silk, which is supposed to be prepared without soap, has a lustre superior to the European.

Another preparation, and one which constitutes, in reality, an important part of the dyeing process, consists in applying to the stuff a material to which it adheres; and afterwards the desired colour is obtained by the application of another substance. We might dye a piece of cotton black, by immersing it at once in ink; but the colour would be neither good nor durable, because the particles of precipitated matter are not sufficiently comminuted to enter the cotton, or to adhere to it firmly. But, if the cotton be soaked in an infusion of galls, then dried, and afterwards immersed in a solution of sulphate of iron, the acid of galls being every where diffused through the fabric, it will receive the particles of oxide of iron, at the very instant of their transition from the fluid to the solid state; by which means a perfect covering of the black inky matter will be applied in close contact with the surface of the most minute fibres of the cotton.

The name of *mordant* is applied to those substances which unite with the different stuffs, and augment their affinity for the various colouring matters. There exists a great number of mordants; some, however, are very feeble in their activity, while others are attended with too much expense for common stuffs; some alter the colours which they are intended to combine, or modify their shades: hence it results, that there are but a small number which can be employed. These are alum, acetate of alumine, muriate of tin, and nutgalls. The mordant is always dissolved in water, into which the stuffs to be dyed are plunged.

If the mordant be universally applied, over the whole piece of goods, and this be afterwards immersed in the dye, it will receive a tinge over all its surface; but, if it be applied only in parts, the dye will strike in those parts only. The former process constitutes the art of *dyeing*, properly so called; and the latter the art of printing woollens, cottons, or linens, called *calico-printing*.

In the art of printing piece goods, the mordant is usually mixed with gum or starch, and applied by means of blocks, or wooden engravings, in relief, or of copper-plates, and the colours are brought out by immersion in vessels filled with suitable compositions. The latter fluids are termed *baths*.

Wool and silk, having more pores, take dyes better than linen or cotton. But wool requires to be cleansed from its unctuous yolk, and silk from its gummy varnish. The first is removed by weak alkali, as much as in urine, which combines and forms a soppy product easily washed off. The latter, the silk, is boiled in weak alkali.

The compounds which form dyes, or colours, are better mixed separately on the substances than applied as compounds. One first, and then the other, and the first applied is called a *mordant*. Then, as the dye is not fixed, except in the part where the mordant is applied, the mordant is laid on by blocks, or plates engraved in patterns, such as we see on linens, cottons, or silks. But, when the whole piece is dipped in the mordant, the second process, or bath, gives the colour of the compound to the whole.

*To make Calico-printer's mordant, or base of alum, for yellow and red goods.* Take 1 gall. of soft and pure water, of a heat of 150°, 3 lbs. of common alum, 1¼ lb. of sugar (acetate) of lead; mix these together, and let them stand for two or three days, so that they may incorporate, often stirring them during that interval; then add 2 oz. of pearl-ash, and the same quantity of clean powdered chalk or whiting. After a time the clear liquor, now become an acetate of alum, must be drawn off. *Or*, Dissolve alum in a solution of crude acetate of lime, (pyrolignite;) a gallon of the acetate, of sp. gr. 1·050 or 1·060, being used with 2¾ lbs. of alum. A sulphate of lime is formed, which precipitates, while an acetate of alumina, mixed with some alum, floats above. The acetate of alumina employed as a mordant for chintz, is still commonly made by the mutual decomposition of alum and acetate of lead. M'Kernan adds 3 oz. of sulphate of copper, omitting the potash; and, when the colour is wanting on the scarlet cast, omit the sulphate of copper. When used, it is thickened either with paste, flour, or gum arabic, or senegal; 4 lbs. of either of the gums to each gallon of liquor. A block or a press similar to a copper-plate press for paper, but much larger, and having the copper-plates in proportion, is employed to spread the acetate of alum from a utensil called a sieve, which is, however, not porous, while a boy or girl, called a *teerer*, works it smooth; when smooth on the sieve, the printer applies his block, and charges it with the acetate of alum; the block thus charged, is correctly put on the cotton cloth, which is laid upon a blanket spread upon a table; it is then struck with a mallet once or twice, by which, or by the pressure of the rolling-press, if copper-plate, the acetate of alum is driven into the pores of the cloth. The cloth, thus prepared, is hung up in a hot stove, and dried by a high degree of heat. The goods are now ready, if for red, for the madder; and, if for yellow, for the weld copper.

To dye linen, or cotton, with red patterns, the mordant is consisting of 6 lbs. of alum, and 1 of acetate of lead, in 2 gallons of hot water, with subsequent addition of a quarter of a lb. of potass and pulverized chalk. This solution, thickened by gum or starch, is impressed on the cloth by the blocks or plates, and the entire piece is dipped in a madder bath. It is only fixed where the mordant is laid, but in other parts may be boiled out in bran and water. Pale reds have diluted mordant and a weaker bath.

The acetate of alumine is often made by digesting it with strong acetic acid, and the alumina itself is purified alum, or real argil. But, the manufacturing chemists economise these processes.

Alum and tartar are the common mordants for woollens. In other cases, metallic oxides produce compound colours with other colouring substances.

The following are the processes adopted, when alum is the mordant employed: 1. *Alum mordant for silk.* Into water containing the 60th part of its weight of alum, at the ordinary temperature of the air, the silk is plunged, and allowed to remain for 24 hours, when it is withdrawn, drained, and washed. If the liquid is warmed, it is found that the silk absorbs less of the mordant, and that, of course, it combines less easily, with the colouring matter, besides losing, in part, its natural gloss.

2. *Alum mordant for wool.* When it is wished to combine wool with this mordant, after its cleansing has been effected, it is plunged into a boiling solution, composed of 8 or 900 parts of water, and 25 of alum, where it is allowed to remain during two hours; when it is taken out, suffered to drain, and washed. Frequently a little cream of tartar is added in this process, in order to engage the excess of acid in the alum, as well as the portion arising from a slight decomposition of the alum by the oily matter of the wool.

3. *Alum mordant for cotton, hemp, and flax.* This operation is effected by plunging the body to be imbued with this mordant into water slightly warmed, and which contains one quarter of its weight of alum, and leaving it 24 hours, at the common temperature of the air; when it is withdrawn, washed, and dried. The cotton will be sufficiently imbued with the mordant, if allowed to remain in the solution only 7 or 8 minutes, pressing it a little, without twisting it, however, on taking it out, and not immersing it in the colouring bath until 12 or 15 hours after.

In all alum mordants for wool, the alum of commerce may be employed; but when silk or cotton is to be dyed, especially if the colours are bright, it is necessary to make use of Roman alum; that is to say, of alum which does not contain above 1-500th of its weight of sulphate of iron; otherwise there will be a great quantity of oxide of iron adhering to the fabric, which will affect the shade we desire to obtain.

Various mechanical contrivances are made use of in immersing the different materials to be dyed into the colouring solution, so as to cause all their parts to be equally affected at the same time. As soon as they are withdrawn from the colouring bath, they are washed in a large quantity of water, in order to deprive them of those particles of colouring matter that are merely superficial.

The following are the dye-stuffs used for producing *fast* colours:

1. *Black.* The cloth is impregnated with acetate of iron (iron liquor), and dyed in a bath of madder and logwood.

2. *Purple.* The preceding mordant, diluted, with the same dyeing bath.

3. *Crimson.* The mordant for purple, united with a portion of acetate of alumine, or red mordant, and the above bath.

4. *Red.* Acetate of alumine is the mordant, (*See* ALUMINE), and madder is the dye-stuff.

5. *Pale red*, of different shades. The preceding mordant diluted with water, and a weak madder bath.

6. *Brown of Pompadour.* A mixed mordant, containing a somewhat larger proportion of the red than of the black, and the dye of madder.

7. *Orange.* The red mordant, and a bath, first of madder, and then of quercitron.

8. *Yellow.* A strong red mordant, and the quercitron bath, whose temperature should be considerably under the boiling point of water.

9. *Blue.* Indigo, rendered soluble, and greenish-yellow, coloured by potash and orpiment. It recovers its blue colour by exposure to air, and becomes firmly fixed upon the cloth. An indigo vat is also made by diffusing indigo in water, with quicklime and copperas. These substances are supposed to act by deoxidizing indigo, and, at the same time, rendering it soluble.

10. *Golden dye.* The cloth is immersed alternately in a solution of copperas and lime-water. The protoxide of iron, precipitated on the fibre, soon passes, by absorption of atmospherical oxygen, into the golden-coloured deutoxide.

11. *Buff.* The preceding substances, in a more dilute state.

A *Blue vat*, in which white spots are left on a blue ground of cloth, is made by applying to these points a paste, composed of a solution of sulphate of copper and pipe-clay; and, after they are dried, immersing it, stretched on frames, for a definite number of minutes, in the yellowish-green vat, of 1 part of indigo, 2 of copperas, and 2 of lime, with water.

*Green.* Cloth dyed blue, and well washed, is imbued with the acetate of alumine, dried, and subjected to the quercitron bath. In the above cases, under 9, the cloth, after receiving the mordant paste, is dried, and put through a mixture of cow-dung and warm water. It is then put into the dyeing vat or copper.

The foregoing colours are also produced from decoctions of the different colouring woods; but, as they possess but little fixity when thus formed, they are denominated the *fugitive* colours. 1. *Red* is made from Brazil wood and peach wood. 2. *Black.* A strong extract of galls and deuto-nitrate of iron. 3. *Purple.* Extract of logwood and the deuto-nitrate of iron. 4. *Yellow.* Extract of quercitron bark, or French berries, and nitro-muriate of tin. 5. *Blue.* Prussian blue and solution of tin.

Fugitive colours are thickened with gum tragacanth, and are sometimes sent to market without being washed.

*Blue dye.*—Take 4 oz. best indigo in fine powder, and 12 ℔s. wool in the grease: put the whole into a copper; and, as soon as the colour requisite is obtained, the wool must be washed and dried. The liquor remaining may be used to produce lighter blues.

*Yellow dye from sulphuret of cadmium.*—If the silk be immersed in a solution of chloride of cadmium for fifteen or twenty minutes, at temperatures between 122° and 140°, then wrung out and immersed at common temperatures, in a weak solution of hydrosulphuret of potassa, it becomes of a fine gold yellow colour, or of lighter or deeper tints, according to the strength of the cadmium solution. This dye is unaltered by sun-light or weak acid, or alkaline solutions. Wool could not be dyed by means of this substance with the same facility as silk.

*Nitrate of tin* is successfully employed in some dye-houses, in dyeing scarlet. It may also be used with advantage in the preparation of the purple precipitate of Cassius. Method of obtaining it:—Bring the acid into contact with the tin in a laminated state, or in the form of ribands, the acid being previously diluted with water until it marks about 4° or 5° of the areometer. Having carefully enclosed it in a well-stopped vessel, leave it to act for several days. By degrees the metal passes into a protoxide, which dissolves without the extrication of much gas; nitrate of ammonia is afterwards found in the liquid, and which is supposed to be formed thus:—Part of the oxygen has been furnished by the water, and another part by the nitric acid, when completely decomposed; this afterwards becomes mixed with azote, and which finally unites with the hydrogen, to form the ammonia. No more of the protonitrate of tin should be prepared at once than is required for use, as it readily decomposes.

*Saxon blue dye*, is used on cloth first prepared with alum and tartar. The colour is made by digesting a lb. of indigo with 4 lbs. of sulphuric acid, over boiling water. Add $1\frac{1}{4}$ gallon of hot water, and stir well, cool, and filter; or, a lb. of potash may be added to the digested liquor before dilution.

*To dye skein cotton yellow.*—The same operations as those in the first common red dye are to be used here; to 1 lb. of cotton 4 oz. of roche alum, and from 1 to 4 lbs. of weld.

When dyed the cotton is to be worked in hot, but not boiling, liquor, consisting of 4 oz. of sulphate of copper to every lb. of cotton; it is then to be boiled for three hours in a solution containing 4 oz. of soap to every lb. of cotton.

When a dark or jonquil colour is wanted, no alum is used; of weld take $2\frac{1}{2}$ lbs., very little verdigris, or a little alum in its stead, but nothing else. For brightening, however, boiling in a solution of soap is in all cases necessary.—*Packer.*

*To dye cotton red.*—If the cotton skein has not been cleansed since it was spun, it must be cleansed by being boiled in a solution of potash, 1 oz. of which, if good, to a pail of water, may be enough, or more than enough. The cotton must be put into bags when boiled, then washed off and passed through clean water, scoured with a little sulphuric acid, and then washed off again; then galled, washed off, and dried. The galls should be white galls: for 20 lbs. of cotton 5 lbs. of bruised galls are boiled in about 120 quarts of water for two hours.

After galling, the cotton must be alumed: 4 oz. of Roche alum for every lb. of cotton. When alumed, it must be washed off and dried.

The cotton is now to be dyed in a copper containing $6\frac{1}{4}$ lbs. of best crop-madder, with a sufficiency of water. The heat is kept under that of boiling for three-quarters of an hour. After being aired, washed, &c., it is put in, worked, and boiled for 12 or 15 minutes. Some dye it again two days after, because the longer, to a certain degree, between aluming, dyeing, and drying, and between one dyeing and another, the better. The second time of dyeing, 8 oz. of madder are used for every lb. of cotton. Some dyers gall it twice, and consequently dry it as often, then dye it at once in the madder, having a proportion accordingly. This is a red full-bodied colour.—*Packer.*

*Black dyeing for silk*, 150 yards.—Boil, for 3 hours, alder bark $1\frac{1}{2}$ bushel, logwood 14 lbs., and iron filings 1 lb. Then dissolve 4 oz. of sulphate of copper in water, and wet out the silk in hot water. Put the sulphate into the liquor and stir it; then put the silk into the copper, and work it from end to end several times. Take it out and let it be aired on the floor, opening it from time to time till it is cold; do the same four times, or give it four wets. Dissolve, and put into the copper 3 lbs. of sulphate of iron, and in this give the silk two more wets.

The next morning give the silk four or five more wets, and leave it in the copper all the following night, keeping the heat considerably under the boiling point, and all the silk covered by the liquor.

*Cotton black.*—Piece-goods are passed through a blotching machine, to receive a mordant of acetate of iron, and galled slightly. The cotton is then passed through logwood, or logwood and fustic, and then through sumach; adding first the galling or sumach slightly; afterwards the logwood, &c.; and then the remainder of the galling or sumach may be used to finish it; and thus dye the goods black by the quickest possible process.

*To prove dyed stuffs, &c.*—The natural proofs of a dye's being effectual, are exposure to the air, to the sun, or to rain. If the colour be not changed by such exposure after 12 or 14 days, it may be considered as fixed. Colours may be arranged in three classes: the first class may be tried with alum, the second with soap, the third with tartar. For the proof with alum, $\frac{1}{2}$ oz. of this salt must be dissolved in a pint of water in an earthen pipkin, and into this liquor is to be put half of a $\frac{1}{4}$ oz. of the dyed thread or stuff, the whole being boiled about five minutes; it is then to be washed clean with water. Thus are tried crimson, scarlet, flesh-colour, violet, ponceau, peach-blossom, different shades of blue, and other colours bordering on these.

The next proof consists in boiling $\frac{1}{4}$ oz. of soap in a pint of water, with half of a $\frac{1}{4}$ oz. of the dyed stuff or thread for five minutes. With this proof all sorts of yellow, green, madder-red, cinnamon, and similar colours are to be tried.

The proof with tartar consists in boiling 1 oz. of that salt, previously powdered very fine, with $\frac{1}{4}$ oz. of dyed thread or stuff, in a pint of water, for five minutes. This proof is used for all colours bordering upon fallow, or hair-brown.

*For Cottons and Linens.*—Acetate of iron is the mordant for *black*, *purple*, and *crimson*; but it is diluted for purple, and acetate of alumine is added for crimson. Madder and logwood are the baths.

*Brown* has the iron and alum mordant mixed, with madder bath. *Orange*, the alum mordant, with madder, and then quercitron. *Yellow*, alum and quercitron, bath at 150°.

Weld, or woad, and also French berries, are used for yellow, the mordant being, for every lb. of cloth, 4 oz. of alum and 1 of tartar; but more tartar renders it paler. The bath is made of about 4 lbs. of weld to every lb. of cloth, boiled in a linen bag. *Silk*, scoured with soap, alumed and rinsed, is dyed in a bath of 2 lbs. of weld to the lb. of silk, raised to 130°. The weld is boiled in another water, and this partly substituted at 180°. Ashes of wine-lees are, in the mean time, dissolved in the residue, and this added, as the shade requires to be improved.

Fustic, also, makes a good yellow, treated in like manner. Its dye is fixed without mordant, but the colour is brownish.

*Logwood* gives a fine red, with shades of orange, yellow, and, in time, black. With acids, it is yellow, and with alkalies, violet. Its mordant is alum and tartar. Alum, in the bath, makes it violet; verdegris, blue. It is chiefly used for blacks, and brazil-wood gives body to the various colours and tints which they are capable of producing. Silk alumed, or soaked in solution of tin, is dyed violet by a cold decoction.

*Green*, is first dyed blue; then put in the alum mordant, and in the quercitron bath.

*Blue*, is produced by a solution of indigo, with potash and orpiment (sulphuret of arsenic,) or of quick-lime and copperas. These render it yellowish green; but cloths dipped in it quickly turn permanently blue, by abstracting the oxygen from the atmosphere. Indigo will not dissolve in water, ether, or alcohol, and only in sulphuric acid, which turns it to yellowish green.

Patterns on blue are made by a paste of sulphate of copper and pipe-clay; and then placing it, stretched, in the quick-lime and copperas vat.

In dyeing with fugitive colours, the coloured woods are used and fixed in degree by nitro-muriate of tin and deuto-nitrate of iron.

After the application of the mordant, the cloth is passed through a mixture of warm water and cow-dung before it is put into the dyeing-vat.

*Madder*, another important dye, and the thin red root of the rubia tinctorum. Dissolved in alcohol, alkali gives it a violet, sulph. acid a fawn colour, and it is precipitated by alum, sulphate of potash, nitre, muriate of tin, chalk, and sugar of lead, in different tints. The mordant is 5 alum, 1 tartar, and different proportions vary the tint. The bath is 5 oz. of madder to a lb. of wool, at 180°. The Turkey madder gives the most brilliant red to cottons, and the acetate of alum mordant already described is the fullest. Mons. Papillon divided the process into nine steps, for 100 lbs. of cotton. 100 lbs. of barilla are to be dissolved in water of 2 strengths; and 20 of pearl ashes, and 100 unslaked lime, in other waters, and the cotton boiled in 10 pails of each. A farage of compounds and preparations then follow, constituting the grey steep, the white steep, the gall steep, two alum steeps, the dyeing steep, the fixing steep, the grey and white united, and the brightening steep of dissolved soap and barilla.

Silks are dyed at a temperature which is gradually increased from 86° to 175°. If above 86° at the commencement, the effect of the mordant is diminished, and the desired shades of colour will not be produced. For the same reason, in dyeing hemp and flax, the temperature should not exceed 97° Fahrenheit. Cotton and woollens may be dyed at a boiling heat.

The leaf of a tree called *Panti*, which grows in Quito, is employed to give a chocolate brown colour. The leaves are used fresh. An infusion in boiling water gives to silk, without the use of any mordant, a very delicate lilac, on which soap produces no other change than to reduce the colour. Acids change the colour of the silk to a very pale reddish brown. Silk, previously boiled with a compound acid mordant, consisting of alum, muriate of tin, and tartar, acquires a bright salmon colour; and, with the same mordant, the excess of acid being neutralized by carbonate of potash, the colour is intermediate between lilac and salmon colour. Wood acquires a reddish fawn colour, and cotton is scarcely affected by the infusion, either with or without mordants.

The leaf of a tree called *Chilca*, a species of Baccharis, which grows near Quito, is used, when fresh, for giving a permanent green to wool. An infusion of these leaves being made in boiling water, gives to silk, without any mordant, a very bright blue-green colour, which loses but little on being washed with soap. If, after being thus washed, the silk is dipped into dilute acid, the colour changes to a very pale lilac, which is again restored to its original green hue by washing with water alone.

*German black dye.*—Logwood is to be boiled several times in water, and a little subcarbonate of potash added to the decoctions, the quantity to be so moderated that it shall not change the colour to blue: the stuff to be dyed is then to be plunged into this bath. When it is impregnated with colouring matter, it is to be withdrawn, and, without being exposed to the air, is to be introduced into a solution of green vitriol, and left there until it has obtained the desired black hue.

The Chinese never attempt to dye fine silks with rich colours, till the dry north-east monsoon, called by them Pak Fung, sets in, when the air becomes excessively dry. This attention to the state of the atmosphere constitutes the secret of the brightness and durability of the Chinese colours.

*Dyeing the hair.*—Take wine 1 pint; common salt 2 drs.; green copperas 4 drs.; boil for some minutes, and then add oxide of copper 2 drs.; boil for two minutes, take from off the fire, and then add powdered nut-galls 4 drs. Rub the beard and hair with this composition, and some moments afterwards with a warmed linen cloth, and then wash with common water.

Another method is oxide of lead, two parts; slaked lime, one part; chalk, two parts. Mix with water, and dip a brush into the preparation, with which the hair must be well rubbed; after two hours washed.

*Or*, Take quick-lime in stone 1 ℔.; yellow litharge and white lead, each 1 oz.; dissolve the lime in water, and stir in the other articles.

DYER.—The trade of a dyer, (says Mr. Packer,) is subdivided into several distinct branches. Thus we have *woollen dyers*, who are occupied solely in the colours obtained from cochineal, such as scarlet, crimson, orange, buff, &c.; likewise purple, or royal purple, obtained from cochineal and indigo. They are called, also, *grain dyers*, from the circumstance of the colouring material, cochineal, being in small grains. Yet the term *dyed in grain* is applied to those cloths, the raw material of which is dyed previously to being spun into thread, or, at least, before woven into cloth; and hence such dyes are usually more permanent than those which are dyed after the materials are woven into cloth. This class of dyers generally dye cloth in the piece, or a number of pieces of cloth tacked together, and worked over a winch in a suitable copper.

There are dyers who likewise dye worsted and woollen yarn of those grain colours, but they are generally a distinct branch. The yarn is dyed in hanks, upon sticks; and, when in the copper, the hanks are changed end for end, so that they may be kept even; such changing being performed five or six times to each turning in.

There are also silk dyers who are grain dyers. These dye in the skein, chiefly for new goods. Some silk, and some mixed silk and worsted goods, are dyed in the piece.

In *dyeing cotton*, the Adrianople or Turkey red is, in many cases, a branch of itself, and comes the nearest to what may be called grain or scarlet dyeing upon cotton, because cochineal cannot be applied to cotton.

In woollen, another branch consists of the *woad dyers*. These often superintend the black dye on woollen cloth, as well as the blue from woad and indigo. There is the same distinction among *worsted yarn dyers*, they having likewise to do slates, greys, &c. Nearly the same may be said of the *silk skein dyers*.

In many places, particularly in the country, browns, drabs, stone-colours, &c. constitute a branch in woollen. The same colours form also a branch in calico and muslin; but *black*, in calico and muslin, is a distinct branch.

The dyers who keep shops, and take in garments, furniture, &c. to be dyed, are termed by the trade *rag dyers*.

There are a few dyers in the metropolis who dye black on woollen, silk, cotton, &c. for the dye-shops, many of these putting all their black out to be dyed.

There are one or two dyers famous for dyeing silk stockings black; these constitute a particular branch. Dyeing bombasins black is also another branch.

The following constitute, also, particular branches:—*black hats; hats of fancy colours; fur; chip and straw; feathers; leather, Morocco and Spanish; and kid leather, for shoes and gloves.* Those who are concerned in them have, for the most part, obtained their knowledge of the art of dyeing from practice in that branch in which they are occupied. They usually, therefore, perform those processes which they have been shewn and told, without any enquiry into the causes which produce the results.

DYSPEPSIA, or diseased digestion. The organs composing the digestive apparatus are numerous. They are—

1. The *mouth*, armed with *teeth*, for mechanically breaking down the food by mastication.

2. The *salivary glands*, furnishing a fluid intimately combined with the food, in mastication, and collected in the stomach, which is its reservoir.

3. The *pharynx*, a muscular and membranous bag, for the reception of the masticated mass from the mouth.

4. The *œsophagus*, a muscular and membranous tube, for conducting the mass into the stomach.

5. The *stomach*, a muscular and membranous bag, or enlargement of the alimentary canal, secreting a fluid or fluids, and a reservoir of the salivary and other secretory fluids, in which the food is subjected to a decomposing process,

until reduced to a pulpy mass, called *chyme*, consisting of the nutritive and innutritive elements, in a state of mechanical mixture.

6. The *duodenum*, or second stomach, in which the chyme is submitted to the action of the biliary and pancreatic fluids, and in which the nutritive elements begin to separate from the innutritive matters, and to be absorbed by the lacteals, or roots of the animal economy.

7. The *liver* and *pancreas*, furnishing bile and a species of saliva, which are mixed with, and act on, the chyme in the duodenum.

8. The *jejunum* and *ileum*, or small intestines, in the course of which the separation, begun in the duodenum, is completed, and nearly the whole of the nutritive principles forming *chyle* are absorbed.

And, lastly, 9. The large intestines, a reservoir for all the excrementitious principles, and which, in it, are converted into fæces, and expelled at the anus.

The whole of these organs compose the apparatus of digestion, but all are not of equal importance. The stomach and duodenum are the most eminent organs, and those whose condition exercises the greatest influence over the powers of digestion. This connexion is maintained through the ganglion of nerves, which not only unites these organs together, but combines them with all their congeries, appropriated to the perfect elaboration of the nutritive and sustaining principles.

The stomach is the centre of the digestive apparatus, and it owes this character to its intimate union with the great *plexus*, or centre of the ganglionary system. It is also immediately associated with the brain, through the medium of the eighth pair of nerves, and thus is placed in relation with the due exercise of the intellectual faculties. The stomach is disposed to be disordered in its functions by violent impressions on these faculties; and they are also affected by disordered conditions of the stomach.

All substances are not fitted for aliment or susceptible of digestion. Food intended for the renovation of the body must consist of the same elements as the animal structure, and contain, at least, three elementary animal principles—hydrogen, carbon, and oxygen, and much of it contains nitrogen. These elements form secondary compounds, in which state alone they constitute aliment: such are albumen, fibrin, gelatin, osmazome, oil, farina, mucilage, and other compounds. The molecules ought to be easily separable without being chemically decomposed, which is one of the primary requisites of digestibility, and to effect which is the chief object of digestion. The masticated food passes into the stomach, and here it is macerated in the saliva collected in the stomach, and in the proper liquid secreted by the gastric mucous membrane, at a temperature of 104° Fah. called *gastric juice*.

The stomach, in a healthy state, contracts on its contents, so that its coats, in digestion, are always in contact with the food; and, during digestion, the stomach has a constant vermicular motion, its muscular fibres contracting, successively, from the smaller to the larger end. The food, thus agitated, acquires a rotatory movement, and is thereby mingled with the fluids. In a short time a change commences, and the food becomes pulpy, and is then reduced to a semifluid, of a light grey colour. From the uniform pressure of the stomach, the solid and most resisting portions are forced into the centre, while the digested and more fluid matter is found on the surface, and is gradually carried, by the contraction of the muscular fibres, into the duodenum or second stomach.

The pulpy greyish substance resulting from the stomachic digestion is called chyme; and, when examined with the microscope, it is found to consist of an immense number of transparent globules, of various sizes, intermixed with undissolved fragments of the fibres of the alimentary substance. When food is masticated, and macerated for a few hours in simple saliva, it presents exactly the same appearances as the chyme of the stomach. The digestion of the stomach is not a decomposition of the alimentary matter, but is a simple disintegration or reduction of it into its component molecules, the character remaining unchanged.

The chyme, having passed into the duodenum, meets with the pancreatic liquor and the bile. The acids of the chymous mass are neutralized by the *alkaline* principles of the bile, the picromel and colouring matter of which coalesce with the food, and assist in their conversion into fæces. Chyle, or the nutritive principles of which blood is formed, do not appear in the lacteals until after the action of the bile and pancreatic fluid on the chyme, the first product of the stomachic digestion. These actions of the stomach on the food are usually called *digestion*, and it is some derangement of this process that is usually expressed by the term *dyspepsia*. The process accomplished in the duodenum is also a true digestion, and symptoms arising from its disordered state are often confounded with those of the stomachic digestion, in the general accounts of dyspepsia.

If the stomach of an animal be examined during digestion, the mucous membrane is found of a diffused scarlet colour. The movements of the stomach essential to digestion depend on its nervous communications, and especially on the integrity of the eighth pair of nerves. When these are divided, the stomach and œsophagus are paralysed; the food is no longer agitated and mixed up with the digestive fluids, and it often regurgitates from the stomach into the œsophagus.

Dyspepsia almost inevitably follows any continued abuse of the digestive functions, from too highly seasoned or too abundant animal food, and stimulating drinks. The constant stimulation of the stomach finally renders it morbid, and the simple prolongation of the excitement essential to digestion, continued from meal to meal, without permitting the stomach to revert to a state of repose, is alone sufficient to constitute a morbid state. All functions, for their perfect performance, require alternate periods of repose and activity; and incessant action irritates, inflames, and finally disorganizes the structure of the organs.

A second class of dyspeptic diseases is connected with the duodenum and its functions. This viscus, similarly constituted to the stomach, is subject to the same morbid alterations. Its mucous membrane is the seat of irritation, in its various grades, and productive of its usual consequences—augmented irritability, sensibility, perversion of secretions, vitiation of structure, and disorder of function.

A third class of dyspeptic diseases depend on the nervous organs, which furnish nerves to the digestive viscera. The ganglionic system of nerves, distributed on each side of the spine, from the head to the pelvis, transmits nerves to all the organs connected with the nutritive function. The stomach, especially, is largely supplied from the solar plexus, and diseases of the ganglions disorder the functions of the viscera, to which they transmit nerves. Hence arises an order of dyspeptic symptoms, independent of any immediate affection of the stomach, but occasioned by disease in the great solar, or other neighbouring plexus. The sensibility of the stomach is sometimes greatly increased. At other times, the secreted fluids of the stomach are morbidly acid. The stomach appears, in other cases, to be partially paralysed, and the peristaltic movements necessary for the admixture of the food, and the gastric fluids, and the continuous passage of the chyme into the duodenum, are suspended. At the same time, considerable quantities of wind collect in and distend the stomach, preventing its action on the food. Mechanical manipulation of the abdomen, and particularly of the epigastrium, after a meal, becomes a substitute for the natural motion of the stomach, and expeling the wind facilitates digestion.

The most common causes of dyspepsia are excesses of various kinds, especially in the quantity of food eaten. Nature commences the work of digestion in the conversion of minerals into vegetables, the juices and substances of which are at once the food and medicine of animals in general. A few only have stomachs adapted to the digestion of the dead carcases of others, as tygers, lions, hyænas, and the like.

Persons of a sedentary life require less nutriment; the economy makes less demand on the stomach for supplies; and the expenditure of the nutritive elements by the economy, and the quantity of food to be digested, must be proportioned to each other, for the preservation of health and the due vigour of digestion.

Food, by cookery, is rendered tender and pulpy, and is reduced to chyme in a shorter period, with a smaller expenditure of the secreted fluids, and less excitement of the stomach, than when it is not so concocted. The art of long and healthful living depends, therefore, on a perfect system of cooking, and a rational and simple mode of eating. The powers of the stomach differ, in individuals, as much as the force of their muscles; and each one must adopt a mode of nutrition, both as to quantity and quality of food, suitable to the wants of his economy.

The quality of food is a frequent cause of dyspepsia. Tough and badly-dressed meats are among the prominent causes of this affliction, as are also hot bread and cakes, heavy and fresh bread, and the daily use of hot tea and coffee for breakfast. Another fruitful source of the digestive disorders is found in the employment of emetics. and in a frequent resort to saline or drastic cathartic medicines. When a constipated habit prevails, it should always be overcome, if possible, by a laxative regimen and enemas, and the aid of purgatives be cautiously and rarely invoked.

**DYNAMICS**, is a collection of rules for determining the effect of one moving body on another, as the effect is either direct or oblique, total or partial. It is a branch of science much mystified by gratuitous and false theories, about original powers, self-moving causes, &c. &c., at the same time NOTHING IS MORE CERTAIN than that there is no material power or force of matter on matter but the motion or momentum of the matter in power, and that its power is merely the exhibition of the translation or transfer of its motion, or part of it, to the moved or patient body.

Hence it follows, that, in all cases where power is displayed, it is merely the direct or oblique action of some matter in some motion: and that in all cases where any body is in motion its tendency is to transfer it to any masses or atoms with which it may come into contact. This, in fact, is the life of material nature, which is the display of direct, oblique, or deflected motions, sometimes massive, sometimes atomic, and sometimes obvious, but often concealed from ordinary observation.

The science of Dynamics, therefore, first traces the causes, or the moving causes, and then calculates their effects as deflected and dispersed in the phenomena. All forces, even that which moves the pen in writing this paragraph, are necessarily derived from other motions, and this principle alone accords with the patient character of all matter, and the constant uniformity and succession of causes and effects.

Every animal derives its vital energies from the moving atoms which it respires and fixes in its system; and every central force is derived from the varied motions of the centre and surface of a planetary mass, while these two species of motion contribute largely to other phenomena of our ordinary experience.

We may thus trace nearly all the motions of the parts and atoms of a planet to its own aggregate motions; and we may ascend higher, and shew that the motions of a planet itself are derived by continuity and radiation from those of its own primary, so as by analogy to connect all nature in consecutive and correlative motions.

All this would be foreign to the design of the present work, but manipulations are so connected with first principles, and superstition is so opposed to just practices, that it is worth while, *en passant*, to found nature on better doctrines than those of forces derived from attraction, repulsion, and similar dreams of the schools and schoolmen.

Nature is matter and motion, and true philosophy is the investigation of the motions and matter which produce all kinds of phenomena. The science of dynamics is merely a collection of the arithmetical and geometrical rules for calculating the precise effects.

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EARTHQUAKE; a trembling of certain parts of the earth's surface. This motion occurs in very different ways, and with various degrees of violence. Sometimes it is perpendicular, throwing portions of the ground into the air, and making others sink. Sometimes it is a horizontal undulating motion, and sometimes it appears to be of a whirling nature. At other times it is quickly over; at others it continues long, or recurs at intervals of week s, days, or months. At one time, it is confined within a small circle; at another, it extends over immense spaces. All the phenomena of earthquakes bear so much affinity to those of volcanoes, that there can be no doubt but both proceed from the same causes, acting differently, according to the difference of situation, or different nature of the strata on which they operate. A volcano differs from an earthquake, principally, by having a permanent outlet, and by the re-appearance of the eruptions in the same place, or in its immediate vicinity. All the other phenomena of a volcano, such as the subterranean thunder-like noises, the shaking, raising, and bursting asunder of the earth, and the emission of elastic fluids, the fire and flames; the ejection, too, of mineral substances, all occur, now and then, more or less, in earthquakes as well as in volcanic eruptions, even when at a distance from active volcanoes; but all genuine volcanic eruptions are, as has been remarked, accompanied or announced by shakings of the surrounding earth.

EARTHS, according to modern chemistry, are universally metallic oxides, or, in other words, metals are earths, deprived of oxygen. Some have properties of alkalies, as lime, magnesia, barytes, &c. Others have no alkaline phenomena, and are called simple earths, as alumina, &c.

Several of the earths are found in a state of purity in nature; but their general mode of occurrence is in intimate union with each other, and with various acids and metallic oxides. Under these circumstances, they constitute by far the greatest part of the strata, gravel and soil, which go to make up the mountains, valleys, and plains of our globe. Their number is ten, viz. *silex*, *alumine*, *magnesia*, *lime*, *barites*, *strontites*, *zircon*, *glucina*, *yttria*, and *thorina*.

*Silex* exists nearly pure, in large masses, forming entire rocks, as quartz rock, and constituting the chief ingredient of all granitic rocks and sandstones, so that it may safely be asserted to form more than one-half of the crust of the earth.

*Alumine* is found pure in two or three exceedingly rare minerals; but, in a mixed state, is well known, as forming clays, and a large family of rocks, usually called *argillaceous*.

*Lime*, an earth well known from its important uses in society, occurs combined with carbonic acid, in which state it forms limestone, marble, chalk, and the shells of snails. It exists, also, upon a large scale, in combination with sulphuric acid, when it bears the name of *gypsum*.

*Magnesia* is rarely in a state of purity, but enters largely into the composition of some of the primary rocks, especially of lime-stones.

The remaining six, (if we except barytes, which, in combination with sulphuric acid, is often met with in metallic veins,) are only known to the chemist.

The Earths are very similar to the alkalies, forming, with the acids, peculiar salts, and resembling the alkalies, likewise, in their composition. They consist of peculiar metals in combination with oxygen, and compose the greater part of the solid contents of the globe. They differ from the alkalies principally in the following peculiarities: they are incombustible, and cannot, in their simple state, be volatilized by heat; with different acids, especially the carbonic, they form salts, insoluble, or soluble only with much difficulty, and, with fat oils, soaps insoluble in water. They are divided into two classes, the alkaline and proper earths. The former have a greater similarity to the alkalies. In their active state they are soluble in water, and these solutions may be crystallized. They change the vegetable colours almost in the same way as alkalies, and their affinity for acids is sometimes weaker and sometimes stronger than that of the alkalies.

The metallic bases of the earths approach more nearly than those of the alkalies to the common metals, and the earths themselves have a stricter resemblance than the alkalies to metallic oxides. Viewing them as forming part of a natural arrangement, they furnish the link which unites the alkalies to the metals.

*Excavating Earth.*—Mr. Palmer, of Worcester, has constructed an engine to excavate earth, &c. It works by steam, and is particularly adapted for cutting canals, levelling hills for railways, and removing large masses of earth. It cuts, at a single blow, six feet in width and three feet in depth—delivering, on either side, or into carts, a ton and upwards per minute. It also cuts and sifts gravel, in the same proportion, for road-making.

EARWIG; an insect, whose name is derived from its supposed habit of insinuating itself into the ears. But this is a vulgar error; nothing can pass into the chambers of the ear, and no case of the kind is recorded in our medical annals. When they, or any insect, enter the external orifice, a little oil or spirit kills them; or, they may be expelled by any blunt probe. Ear-ache is best relieved by laudanum or garlic, and best prevented by lavations of cold water every morning.

EARTHENWARE and Porcelain.—The art of the potter, or the manufacture of earthenware and porcelain, present, in as great plenitude as any other, opportunities for the exercise of taste and genius, in regard to the elegant and beautiful in design, and the useful and scientific in research.

Neither earthenware nor porcelain can be perfect, unless it be fabricated from a suitable body, formed in definite proportions, (chemically regarded,) of the chief components, alumine and silica. And in this quality of proportions consists all the difference between excellent and worthless ware.

*Alumine* so imbibes distilled water as to retain a tenth of its weight, even in a heat that would fuse iron. In masses, its presence is known by a peculiar scent, when breathed upon; when moist, a clammy plasticity adapts it for being worked upon. When pure, and with distilled water, made fit for the potter's manipulation, it contracts, by common drying in the air, one-twelfth of the dimensions of the vessel. The contractile nature of alumine affects all clays, but is counteracted by an adequate dose of silica.

*Silica* exists, in a tolerably pure state, in rock crystal and quartz; and less pure in flint. By calcination, flint is deprived of its water of crystallization, and, by grinding, reduced to an impalpable powder; yet, mixed with water, for more ready combination with alumine, to render more white the wares formed of these components, the acidulous nature of the flint, excited by the very high temperature, affects the bibulous nature of the other earth, and they firmly unite without fusion.

*Magnesia*, alone, is infusible by the most intense heat, yet, combined with alumine and silica, fuses into a non-contractile mass. Because of this peculiar property, the *steatites* rock (usually called *soap rock*,) is, by some manufacturers, employed as one component of their porcelain.

*Lime*, either dry or in water, combines (and in excess will fuse) with silica; and more readily, when alumine is present. In furnaces, the first greatly attenuates the others, and by reciprocal tendency towards each other, they leave the metal to the more ready action of the carbonaceous fuel. Something similar is the effect of lime, combined with alumine and silica, in the manufacture of earthenware and porcelain; for, when there is in the *body*, or *clay*, only such exact quantities of the other substances above-named, as will saturate and neutralize each other, the addition of less than 6 per cent. will be useful, in increasing the vitrescence.

*Barytes*, dry or in water, has a weak tendency to combine with alumine and silica; yet, like the other two alkaline earths last-mentioned, their fusibility seems increased by its presence. At the usual temperature, 60° Fah. only, in the proportion of 10 per cent. it combines with water; but, in water, at 212°, the tendency is about 50 per cent.

The *China clay* and the *Cornish stone* are *spiced* with *mica*, from the granite, which is easily affected by the phosphoric and boracic acids; and these opposing tendencies require to be neutralized in the arraugement of the proportions of components.

The *Chert*, (or hornstone) will neither give sparks, by striking against steel, nor effervesce with acids.

The *Felspar*, (introduced by Mr. Ryan,) is extremely useful. The *greenish* kind being fusible at a moderate heat, yet not reducible by any temperature, is very valuable for *bodies*; and the *flesh-coloured* and *white*, which burn white by a proper combination, when mixed with alkalies which hold a fixed acid, (as boracic or phosphoric,) can be rendered available for the best and most delicate *glazes*. The softening tendency of their components greatly promotes the action of the saline flux upon the silica in the body, and no force of aggregation in the materials can withstand the other forces opposed thereto. The *felspar* glaze is most beautiful, when on a body, in which 4 per cent. of barytes is introduced, in lieu of an equivalent quantity of alkali abstracted from the porcelain clay. Its remarkable tendency to render the baked mass more compact, in proportion to the high temperature employed, will suggest many hints for the production of yet more compact and vitrescent porcelain.

The *phosphate of lime*, or *bone*, is procured from bones, boiled until all their gelatinous matter is extracted. Afterwards they are calcined, and next ground to an impalpable powder. A ready method is adopted by some manufacturers, and is less obnoxious in the effluvia which escapes than the former:—a small oven is used; through the centre is a tunnel bung of saggers, and the bags are well covered; then the whole space is filled with bones; the entrance is closed, and into all the mouths fire is immediately placed; the smoke and the effluvia rapidly are consumed, and in ten or twelve hours the calcination is completed.

The process of *fritting* is adopted, that, by subjecting the components some hours to a gradually-raised temperature, all moisture, carbonaceous ingredients, and carbonic acid gas, may be completely expelled; and, also, to commence and promote a full chemical union of the silicious, alkaline, and metallic components; that none of them may precipitate when in the fluid glaze. The *cullet* is made friable by heating red and immersing in cold water; and it is added after the other components are *fused*, but not fritted; the greatest care being exercised that none of them are volatilized.

*Pressing of Earthenware and Porcelain*, is technically named *squeezing*, and, for some articles, is one of considerable labour. That its nature may be fully understood, it is necessary to state, that a *modeller* in clay produces a *model* of the article; and from this is formed one or several *blocks*, from which are cast the requisite number of moulds, or *moods*, by the *mould-maker*, whose attention is required to mix with water a sufficient quantity of gypsum, calcined and ground (*boiled* is the usual word,) evaporated on a kiln; this he pours around the block, and into a space surrounded by a curtain of clay, and left a short time for the *plaster* to set, or become sufficiently solid. These moulds, while being used in any of the several manipulations wherein they are requisite, are placed on shelves around a heated stove, that, by their dryness, they may more readily imbibe the moisture of the clay placed in contact.

The *presser* considers well the size of the mould and the thickness of the article he is fabricating. With a brass wire he cuts from a mass of clay before him a piece sufficient for his purpose. This he repeatedly squeezes in his hands, forms into a ball, and forcibly casts down on his bench or board, that no air-bubbles may remain in it.

The mass is next beaten flat, to the proper size and thickness, by an expertness only to be believed by witnessing. When several of these *bats* have been prepared, and remained a proper time, the presser takes the several parts of his mould, and on each lays the requisite size of the bat, which, by his thumbs, he forces into all the parts of the mould, whatever be its form and ornaments. He then carefully smooths the inner surface with a sponge, trims off all extra portions from the edges, moistens with slip all the edges, places all parts of the mould in proper connection, when needful secures the whole by a belt buckled round them, and then places the mould and its contents on a shelf near a stove, where it remains, until the moisture is sufficiently dispersed; after which, the mould is separated, and the vessel, or other article, is, by proper tooling and trimming, freed from all appearances of seams; and whatever other ornaments or figures are requisite are attached by a process called *handling*, and the whole is properly finished, and placed to dry, preparatory to becoming baked bisquet.

*Handling, &c. of Earthenware and Porcelain.*—This manipulation fixes on vessels the *handles*, *spouts*, and *snips*, and is a distinct branch of the *clayman's* duty. Handles, for common vessels, are prepared by a *box and screw*. Into an iron cylinder is fitted a piston, attached to a double, or very close single screw, on whose upper end is fixed a transverse handle and bar. At the bottom of the cylinder is an aperture, into which is fitted a piece of lead, perforated in a certain form, agreeably to the taste of the workman or his employer. The piston being drawn out, a mass of clay is put into the cylinder; the power of the screw is applied, which forces the clay through the lead-piece, in lengths, on a board, where they are left a short time to dry.

These lengths are afterwards cut into the proper sizes, bent into required forms, and left to dry.

This box is also used, with a piece of lead, and a round piece of steel, properly fixed in the centre of the aperture, to form tubes of various sizes, and for ornamental tobacco-pipes.

But many handles, all spouts and snips, are first formed in moulds, as described under *Pressing*, from proper-sized pieces of well-slapped clay, and left therein a short time, to become ready for fixing.

Having taken his handles, spouts, and snips out of the moulds, with a sharp knife, he cuts off the edges, to a level, of the handle, spout, or snip, and levels the cylindric surface of the jug, &c., then cuts out of the side, or the upper edge, the orifice in which is to be inserted the spout or snip; he next moistens with slip the edges, places them together carefully, and lets them be undisturbed a few minutes, when he again inspects them; and, when they require, adds a little more slip, and fills up, by pressure, any crevice left. They are then left till sufficiently dry to be trimmed and finished, and are afterwards placed in apartments properly heated, to become ready for baking.

The handler has always a number of moulds in his charge, and while those of one series are around the stove, he is fixing on his ware the various parts previously taken from them.

Small and beautiful figures are pressed into moulds, dried, and fixed on vessels, by handlers of extra genius and dexterity.

*Throwing of Earthenware and Porcelain.* — Fitted into a corner of the room is a kind of box-shaped frame, with a curved front, about a yard square. In the centre of this is the head of the *thrower's engine*, which, altogether, consists of a spindle or axis, working vertically, in a collar and step. On the lower part is fixed a pulley, of different diameters, for increased or diminished velocity. At the distance of three to five yards stands a large wheel, from four to six feet in diameter, from which the driving cord passes under a guiding pulley, near the ground, to the spindle of the throwing-wheel, or thrower's engine.

In some manufactories, we find double cones placed inversely on parallel shafts, from one of which (driven by the steam-engine,) passes a belt to the other; and the position of this belt gives increased or diminished velocity to the cone, which gives motion to the thrower's engine, and is directed from the apex to the vertex by a simple contrivance of a directing lever.

At a bench, near the throwing-engine, stands another person, usually a young woman, with a mass of clay before her, from which, with thin brass-wire, she cuts off a piece of the size required, and occasionally *weighed*, when the body is valuable, and the vessels must be of a certain size. This lump she well squeezes together into a ball, (whence she receives the appellation *baller*,) and afterwards passes it to the man, as he requires to be supplied.

In the corner of the frame already described is placed a low seat, on which the thrower sits, with his feet on the sides near the wheel-head, yet supplying resting-places for his arms, when they must be very steady. On the side of the frame he fixes in a lump of clay, a peg or stick, at a certain distance from the centre, which serves to indicate the height and expansion of the vessel he has to form.

He then casts, very forcibly on the head, a ball of clay, as the motion is given, and, by his hands, forms it into a high conical shape twice or thrice, the better to preclude any air-bubbles remaining in the clay. Then, with one hand, or finger and thumb, *in* the mass, and the other on the *outside*, he shapes the mass into the rude figure of the intended vessel. He next applies to the inside a *swage*, or pattern, (formed of earthenware and well glazed;) and then, with a brass wire, cuts it loose from the head, while the baller instantly hands him another ball, and with great facility lifts off the vessel, and places it on a board, on which it remains (occasionally turned upside down) until the whole is become sufficiently dry to bear, without injury, the subsequent manipulations of the *turner* and *handler*.

*Firing of Earthenware and Porcelain.*—The potter's oven is a cylindrical kiln, surmounted by a dome, in which is an aperture from 18 to 24 inches in diameter. On the outside of the kiln are semicircular fire-places, or mouths, for the fuel; in number from four to ten, according to its size; the kilns for baking the *bisquet* being rather larger than those for the *glazed* state. Each mouth is connected with a flue to the centre of the sill of the oven, and also with a *bag*, inside and vertical. The best fire-bricks are used for all the interior of the oven.

The baking or *firing* is accomplished in *saggers;* (from the Heb. *sagar*, to burn ; and, hence, used for a roll of tobacco-leaf, employed for *burning*, while the smoke is inhaled.) These saggers are formed of can-marl 2 parts, and black marl 1 part; (or of pulverized coarse pottery, pulverized, sifted, and mixed with malls;) well slapped, or beaten together, and in bats of 1 inch in thickness, fabricated around wooden drums, of the shape and size required by the vessels which have to be baked; and inside of some are ranges of triangular holes, for the insertion of pegs, when plates or dishes are baked.

Into these saggers the vessels, in their *clay* state, are carefully placed; and to prevent their adherence by the fusion of their outer surfaces, pulverized *grit-stone* is put between the ware and the saggar. The best DRY bodies, as jasper, pearl, &c. and the porcelains, are embedded in ground flint, firmly, as a matrix, to prevent *wauving*, (waving, or altering of the shape,) which else would be consequent on the very high temperature.

The second process of baking, for properly fusing the materials of the *glaze*, is also on saggers, with the vessels therein placed on *stilts*, *triangles*, *cockspurs*, *rings*, *and pegs*, as well to prevent their adherence by the fusion of the glaze on each, as to allow the oxygen fixed by the supply of fuel, to properly affect all the surfaces especially, and the body of the wares.

When salt was employed, that the muriatic acid gas evolved might aid the oxygen in partially vitrifying the surfaces of the wares, each sagger had several holes in its sides, for the ready ingress of the heated particles. Each oven had around it a stage, and over each bag was a hole, into which the salt was cast at certain intervals of time; and a dense white vapour was produced, which, when fully practised in the Staffordshire Potteries, not infrequently exceeded in density the most dense November fog of London.

The saggers, when filled, are piled vertically in *bungs*, each being placed on a *wad* of clay, that the whole being thus, as it were, one mass, none of the ware may sustain injury from the carburetted hydrogen evolved from the coals. In different parts of the oven, pipe saggers are fixed, to promote the baking. In certain saggers are placed *trial pieces*, which can be taken out by a long iron rod at pleasure. The oven is in this manner filled; the entrance is closed with bricks, and every crevice is filled, and the whole is covered with mud, to prevent loss of heat. The fires are gradually increased for about 45 hours, and then urged in the most rapid way for 3 hours longer, till the whole is at the heat of 15° Wedgwood. After cooling a few hours, the entrance is opened, and the whole is left to cool gradually, and then sorted from the saggers into the baskets.

The greatest celerity is adopted in carrying the ware from the oven into the sorting room, where every article is carefully examined, and by its *sound* tried whether fit for further processes, and when so, it is placed in the biscuit warehouse; as *good*, when perfect; as *seconds*, when slightly injured, yet sound; and as *lump*, or thirds, when defective, yet sound in structure. All *cracked* articles are cast aside, and consigned to the *shord-ruck*.

For the final baking of those articles which have undergone the processes of black printing, enamelling, or gilding, a MUFFLE is employed, varying in capacity, for the kind or quantity. This is usually in the form of a double cube surmounted by an octagonal cupola. It is formed of large flat bricks, from 2 to 3 inches thick, and 18 by 10 in surface; which are placed edgewise for completely precluding the entrance of sulphur, while the ware is baking. Considerable judgment is requisite, for properly placing the different articles in this kiln. A layer is placed, then props are fixed in certain parts, which sustain bats, of about half an inch thick, and from 20 to 30 by 12 or 16 in surface. When the muffle is filled, and the aperture closed, the fire is continued at a moderate temperature till the glaze is rendered sufficiently porous for imbibing the mineral particles of the colours, and amalgamating with the enamel that was their medium. As soon as this is accomplished, the fires are withdrawn, and the ware is allowed to cool as regularly as possible; after which it is examined, and that which requires *burnishing* is put immediately into the burnisher's room, and afterwards carefully wrapped up in fine tissue paper.

*Painting biscuit, (or blue.)*—This manipulation is now practised only on earthenware, and the least valuable description of this kind of pottery. The patterns are those most demanded in the market, and they are traced by camel-hair pencils on the surface of the jugs, tea-ware, table-ware, &c.

*Printing (black).* This manipulation is for delineating, on the glazed surface of pottery, designs from copper-plates, of a description different from those adopted in *blue* printing. The workman takes a definite quantity of good glue, which he boils in water for about 4 hours, and then pours it out on very well glazed large and flat dishes. When cold, he cuts this substance into pieces corresponding to the sizes of the plates he is about to use, and technically calls them *papers*.

He next prepares his colour, by rubbing it in a saucer till completely dry and in an impalpable powder; and dries a lock of fine cotton well, for applying the powder. Then having his plate fixed by rosin to a small prism of wood, for convenience of holding, he rubs into the engraving a small portion of best oil (usually cold-drawn linseed,) mixed with a little spirits of turpentine. With much pressure he applies this plate to the glue paper, to which the oil adheres. This paper he immediately lays carefully on the ware, and by a gentle pressure the oil is again transferred to the glazed surface. The paper is cleaned with a damp sponge, and left to dry. He takes the ware up, and with the cotton dusts on the moistened part some of the colour; and afterwards proceeds similarly with others till his papers require rather longer time to resume their adhesive power. Then he cleans off, with old silk rags, all the superfluous colour, and wipes the whole from every particle likely to adhere to the glaze. The edge and other parts are next *topped* and *lined* with gold, or any other required colouring, and, when dry, the articles are placed in the muffle for final baking.

*Printing (blue.)* — The engraved plates from which impressions are taken for this purpose, are executed in a style peculiar to the Pottery districts, by punches and manual ingenuity. Their sizes vary with the articles to be ornamented.

The *press* is similar to that used by copper-plate printers; and is constructed alike, very strong and large. It is placed near a heated iron-plate, (as a stove,) on which the plate used is laid, while into its graved part is rubbed the fluid which contains the colour.

This fluid it technically called *oil*, and is prepared in the following manner:—Over a slow fire, for 2 hours, boil in a covered vessel 1 quart of pure linseed-oil; afterwards add 1 pint of best rape-oil, and 2 oz. of capivi balsam, and continue the boiling 2 hours more. When cooled to 160° add of amber oil, white oxide of lead, and clean pitch half an oz. each; then raise the heat again to 212°, and continue it from 3 to 5 quarters of an hour, as the tint may be required very strong, or moderately weak.

Some printers substitute, for the oil, lead and pitch, a little oil of tar, and 1 oz. of balsam of sulphur, (very carefully introduced, else all the mass would coagulate.)

Into this oil is ground, on a hot plate of iron, whatever quantity of colour is required for the tint; and which is compounded of blue calx 4 parts, dry flint 5, nitrate of potass $\frac{1}{4}$, and borate of soda $1\frac{1}{2}$, well ground together.

The copperplate printing for this purpose differs very much from that for books, &c. for it is performed while the plate is so hot that the printer has his thumb and finger guarded by thick pieces of leather; and that the colour which he rubs into the engraving would scald his hand, was he to offer to clean the plate in the usual way. The workman with a very thin and broad pallet-knife scrapes off the superfluous colour, and with a boss of well-stuffed leather cleans the surface. The piece of tissue paper he brushes over with a very strong mixture of soft soap and water, places it on the plate, and the instant the return of the press leaves it dry on the heated plate, he quickly takes it off, and the oil and colour are found adhering to it.

The impression is handed to a *cutter*, (a little girl) who immediately cuts away all the white paper, separates the several parts of the impression, and places them in the proper places and order for being readily taken up by a woman called the TRANSFERRER.

This manipulation requires much tact and judgment. A roll of flannel is firmly secured, to the length of from 6 to 16 inches, and is called a rubber. The ends are softer, one being to act on the paper, the other against the hollow of the right arm-pit, (for large impressions.) The transferrer takes a vessel in the bisquet state, placed on the several parts the proper portion of the impression, and with her rubber works on the paper till it is almost rubbed into the substance of the pot itself. The porous and absorbent nature of the ware renders easy the adherence of the well-charged oily particles. The vessel is then placed on a board, and after some time a brush, soft soap, and water, are applied to wash away the paper, and leave only the mineral colour, if possible.

The next process is *hardening on* ; by which is meant, that the printed ware is placed, first in a highly heated apartment, that the water imbibed in washing off the paper may be evaporated; and next in another, where it is heated to redness, to volatilize the oily particles of the colour. Both being indispensable, for otherwise, there would be prevented the adherence of the watery mixture, the *glaze*, when the ware was immersed for this purpose.

Earthenware manufactures are divided into three kinds, those of, 1. Porcelain ; of 2. Pottery ; and of 3. Crucibles, bricks, &c. The following is the composition of certain porcelains :—

| | *Sévres.* | *English.* |
|---|---|---|
| Silica .......... | 0·596 | 0·770 |
| Alumina ........ | 0·350 | 0·086 |
| Potash .......... | 0·018 | |
| Soda ............ | | |
| Lime ............ | 0·024 | 0·012 |
| Magnesia ...... | | 0·070 |
| Water .......... | 0·008 | 0·056 |
| | 0·996 | 0·994 |

Sévres service, paste strongly heated, is formed from 0·63 washed kaolin of Limoges; 0·105 quartz sand; 0·052 Bougeval chalk; 0·21 of the fine sand obtained from kaolin by washing, and which is a mixture of quartz and felspar. The glaze of this ware is made of a rock composed of quartz and felspar. When reduced to a fine powder, it is found to be composed of silica ·730, alumine 162, potash 84, water 6 : it fuses into a perfectly transparent and colourless glass.

In the porcelain of Tournay, clay, chalk, and soda enter into the composition. It is very fusible, but not very fragile.—*Simeon Shaw.*

EATON'S STYPTIC.—In 2 lbs. of alcohol, just tinged yellow with oak bark, mix 3 oz. of copperas calc, (or of red oxide of iron.)

EAU DE COLOGNE.—Mix 3 oz. of essence of bergamot, an oz. and a half of essence of neroli, (or alcohol 1 oz. orange-peel 6 drs. orris-root 1 scruple, and ambergris half a gr.) 2 oz. of essence of lemon-peel, 3 oz. of essence of lemons, 1 dr. of oil of rosemary, 12 pints of alcohol, 3½ lbs. of rosemary sprigs, and 2 lbs. 4 oz. of compound honey-water. Distil in a water bath, and keep in a very cold place; a cosmetic externally, and mixed with one-fourth its weight of refined sugar, *ratafia.*

*Or*, Alcohol 4 pints, mixed with 24 drops of the essences (above) neroli, citron, orange, bergamotte, and rosemary, with 2 drs. of cardamom seeds. Distil in glass retort.

*Or*, Alcohol 2 pints, 2 drs. of essence of citron and bergamot, 1 dr. of essence of lemon-peel, ½ dr. of essence of lavender, 10 drops of essence of orange-flowers, and ambergris tincture, ½ dr. of essence of musk, 3 drs. of tincture of benjamin, and 2 drops of essence of rosemary; mix, and filter.

The only essences which are employed, and which confer on this water its great celebrity, are the following : bergamot, citron, lavender, rosemary, Portugal, and *neroli.* All these should be of the first quality; but their proportions may be varied according to the choice of the consumers.

The following is also an excellent recipe for making *Eau de Cologne*, equal to that of Farina, and at one-fourth of the price.

Take of the essence of bergamot, lemon-peel, lavender, and orange-flower, of each 1 oz. ; essence of cinnamon, half an oz. ; spirit of rosemary, and of the spirituous water of melisse, of each 15 oz. ; strong alcohol, 7½ pints. Mix the whole together, and let the mixture stand for the space of a fortnight; after which, introduce it into a glass retort, the body of which is immersed into boiling water contained in a vessel placed over a lamp, while the beak is introduced into a large glass reservoir well luted. By keeping the water to the boiling point, the mixture in the retort will distil over into the receiver, which should be covered over with wet cloths. In this manner is obtained pure Eau de Cologne.—*Granville.*

EAU DE LUCE.—Dissolve in 1 oz. of alcohol 10 grs. of Castile soap, and 1 scr. of oil of amber ; then add 4 oz. of caustic ammonia. *Or*, In 12 oz. of alcohol, dissolve 1 oz. of turpentine ; (or, 1 oz. of mastich;) to which, as wanted, add one or several drops of caustic ammonia.

*Or*, Rub together 1½ dr. of oil of amber, and 3 dr. of subcarbonate of potass, and gradually add, (still triturating,) 4 oz. of alcohol; digest 15 minutes, and decant. This liquid is added in the proportion of 40 drops to 1½ dr. of caustic ammonia, and form the milky *Eau de Luce*, which does not decompose or settle.

EDUCATION, that art of life on which is built all others. It consists in breaking in the wild young animal, by habits of order, submission, and self-government; and in teaching what is already known to mankind as results of past discovery and experience. It is a practical art, and not a theory; and success in it depends chiefly on the zeal, attention, and example of the preceptor; on the example set by parents, and family; and on the encouragement and distinction acquired by diligence, attention, and good conduct in pupils.

In learning, the object is, or ought to be, to impress the memory, and oblige the pupil to think for himself on the subjects of his study. In teaching dead or living languages, this is effected by reiterated exercises; so also in arithmetic, and in manual and imitative arts, as in writing, drawing, dancing, music, &c.; but other liberal studies, as native language, geography, history, natural philosophy, theology, &c. &c. were unprovided with any impressive means of exercise, till the introduction of the *Interrogative System*, or of Questions *without* answers; and which questions are by this system to be answered by the personal study and attention of the Pupil. The writing of the answers is at the same time a continued exercise in orthography, grammar, punctuation, and reasoning; while the search for them in the Text-book, on which they are made, is a continued self-study of the subject.

To facilitate the introduction of this course of instruction into cheap and popular schools, the questions have also been provided with Keys, for the ease and convenience of teachers, and the text-book, the questions, and the key, constitute the Editor's well-known Interrogative System, whose sufficient praise it is that it is adopted in many thousand of the best-conducted schools in the United Kingdom.

Empirical modifications of all kinds and theories, out of number, with refined closet speculations, &c, &c. have been opposed to this plain theory, though it is, and must always be, the *only* mode of acquiring and impressing knowledge. But the preceding short explanation cannot fail, among persons of experience on such subjects, to put all misrepresentations on so plain a practice to flight, and open the eyes of those listless persons who confound Questions *without* answers with stupid catechisms and books in question and answer.

The tools of schoolmasters are Books, and to them they are equivalent to the saw, the plane, and the chisel of the carpenter. There are good books and bad books, as well as bad saws, planes, and chisels; but the intelligent schoolmaster, like the experienced carpenter, will soon know how to distinguish between the genuine and the specious. The names of Blair, Goldsmith, Barrow, Robinson, and Adair, designate the various books on the Interrogative System, and none, for equal time, ever enjoyed a more extensive reputation.

The entire course of the Interrogative System may be pursued without interfering with other fashionable studies, and, as far as it is followed, the result is necessarily a most intimate acquaintance and intellectual familiarity with the subject.

Since knowledge is to be found in books, so the art of reading ought to be taught to all, and arrangements for this purpose ought to exist in every parish or district. No man can justly be made responsible for failure in duties, or breaches of law, who is unable to make himself acquainted with them by reading. Writing and computing are also other primary arts, with which all ought to be made familiar in the age between five and ten, or twelve.

In every population a third are of the age of adolescence, or of a fit age to learn the fundamentals for use in future life. Reading is the first acquirement usually commenced between 3 and 6 years of age. Writing begins at 5 and continues till 10 or 12. Arithmetic, a very important study, commences at 7 or 8, and continues through the season of education. Grammar is another essential object from 9 to 12. And Geography, and at least the History of native country, should be taught to all.

A living Language, as French or German, may be superadded after 12, and some Algebra, and at least practical Geometry. At 13 or 14 boys and girls are expected to learn some trade, or in some way to be useful to their parents.

Though manners make the man, yet there is in schools no direct means of inculculating its practice and principles. It is to be acquired from the examples of parents and associates, but we want some elementary book on manners.

Of course, interrogatories mean questions *without answers*, the object being that the students should frame their answer as the result of their own research.—It cannot be too often repeated, that books in question *and* answer are *not* the Interrogative System, and such have for too many years been frauds on teachers and the world, whenever they are put forward or adopted as the Interrogative System.

A Swiss schoolmaster, of the name of Pestalozzi, lately adopted the Interrogative System in a very expensive establishment in that country. His system is, however, *different* from the English, in being *oral*; but as oral questions imply more perfect knowledge and leisure in the tutor, than 1 in 100 can possess, and as the answering of questions in writing effects several objects at the same time, there can be no question but the British system is far superior, as well as better adapted to the routine business of schools for numbers.

The British system consists of about

500 *dodging* questions from a text-book, on the particular subject, with a key to the answers for the ease of the tutor. Questions placed at the end of chapters of books in the exact order of the text, totally fail in the main objects, which are exercise, research and self-thinking.

At the revival of letters in the 16th century, Latin was the established language of the church, law, and physic, and, in fact, of all learning, for the English and other vernacular tongues had been wilfully neglected by the Roman Conquerors and Monks. There was no English Grammar, nor even a book of arithmetic. Hence the schools founded by the Government were Latin, or Latin and Greek Schools, with clerical masters. From neglect, inadvertency, or predilection, this obsolete monkish system is continued even after the English language itself has arrived at greater perfection than Latin.

The absurdity of the practice is however so gross, that the greater part of the foundation Latin schools, though free of cost, are deserted by those for whom they were intended, and the office of master has become in many cases a mere sinecure, and the endowments a waste.

An Act of Parliament alone can correct this folly. Exercises at Universities ought to be in English, not in dead languages; and the range of studies ought to be rendered accordant with the improved knowledge of the age. What is taught is precisely that which is of no use out of the school or university, and which, if quoted in any society, would expose the witless student to general ridicule. In fact, the monkish system is too absurd to last much longer, since it is as irksome as it is useless and ludicrous. Every boy knows that all the drudgery of his early years in Latin and Greek, and in the higher mathematics are inapplicable to the business and duties of life, and if such cease to be made the steps of scholastic distinction, the next following age will marvel at the inveterate stupidity of their ancestors.

EGG-PLANT. In this country, the egg-plant is chiefly cultivated as a curiosity; but in warmer climates, where its growth is attended with less trouble, it is a favourite article of the kitchen-garden. In the form of fritters, or in soups, it is brought to table in all the southern parts of Europe, and forms a pleasant variety.

EGGS, (*preservation of*,) Immersion in lime-water preserves eggs for years, and when boiled they are found perfectly fresh and good. Eggs may be thus preserved in jars introduced when quite fresh, and the bottle then filled with lime-water, a little powdered lime being sprinkled at last. To prepare the lime-water, twenty or thirty pints of water are to be mixed up with five or six pounds of slaked quick-lime, put into a covered vessel, and allowed to clear by standing. Fat, &c. rubbed on eggs also preserves them.

EIDER DUCK. This valuable bird is found from 45° north to the highest latitudes yet visited, both in Europe and America. In particular spots, their nests are so abundant, that a person can scarcely walk without treading on them. The eider duck is about twice the size of the common duck. Their nests are usually formed of drift grass, dry seaweed, lined with a large quantity of down, which the female plucks from her own breast. In this soft bed she lays five eggs, which she covers over with a layer of down; then the natives, who watch her operations, take away both the eggs and the down: the duck lays a second time, and again has recourse to the feathers of her body to protect her offspring: but even of this, with the eggs, she is generally robbed, and it is said, that, in this extremity, her own stock being exhausted, the drake furnishes the third quantity of down; and, if the robbery should be repeated, they abandon the place.—One female generally furnishes about half a pound of down, which is worth about nine shillings. This down, from its superior warmth, lightness, and elasticity, is preferred by the luxurious, to every other article for beds, and coverlets; and, from the great demand for it, those districts in Norway and Iceland, where these birds abound, are regarded as valuable property.

With five pounds of the best eider down, a whole bed may be well filled. The Greenlanders likewise use the skin, taken off, feathers and all, for their under-dresses. The down is divided into two sorts; sea-weed down, and grass down. The former kind is the heaviest; but the labor of cleaning is greater. Much of the down is lost in cleaning.

ELAIN, the oily principle of fat, obtained by submitting fat to the action of boiling alcohol, allowing the stearin to crystallize, and then evaporating the alcoholic solution; or, by the simple process of pressing any oily or fatty substance between folds of bibulous paper, the oily matter or elain is absorbed, while the stearin remains. The paper being then soaked in water, and pressed, yields up the elain. It possesses much the appearance and properties of vegetable oil, is liquid at the temperature of 60° Fahr., and has an odour derived from the solid fats from which it has been extracted. It is readily soluble in alcohol, and forms soaps with alkalies; in doing which, however, it undergoes decomposition, and is converted into *oleic acid*, which combines with the alkali employed.

**ELASTICITY**, the mechanical property of bodies, by which the particles of which they are composed, when moved out of their positions by an external force, or pressed into a narrower space, return to their former position, as soon as the external force ceases to act. A bow, bent by the tension of the string, recovers its previous form when the tension is relaxed.

In gases and fluids it is the result of the orbits of atoms which compose gases or fluids, or fill the interstices of solids. When these orbits are enlarged it is called *expansion*, and when lessened it is called *contraction*.

In all elastic fluids, the specific elasticity increases with the temperature; it is likewise augmented by greater density; if air is confined, and made more dense, its specific elasticity is greater in proportion to its increase of density.

Gaseous forms are enlarged by more heat or motion, and diminished by less heat. It is different in different fluids, at the same temperature, *i. e.* the orbits are of different sizes. Thus, in water at 21°, it is 28·88, but in ether at 210 is 166, and in alcohol 65. And, again, in petroleum at 320°, it is 31·7, and in oil of turpentine, at 320 is 37·06, also in water at 250° it is 61·9, but in alcohol 132·3.—Thus, in engines, the expansive force might be increased with the same fuel, but for the great expence of the material.

In elastic solids, the structure or network of the parts effects the restoration of the form of the aggregate.

**ELDER.** The elder-tree does good by its noxious and its agreeable qualities. If corn or other vegetables be whipped with the branches, they will communicate a sufficient portion of scent to keep off insects, by which many plants are frequently blighted. An infusion of the leaves poured over plants preserves them from caterpillars. The wine made from the berries is valuable, and the buds make excellent pickle. Water distilled from the flowers is a rural cosmetic. It furnishes ointments, infusions, and decoctions, for many ailments, cuts, or bruises. The wood, pith, bark, leaves, buds, flowers, and fruit, are useful; but its narcotic scent makes it unwholesome to sleep under it.

**ELECTIVE ATTRACTION.** Affinity, or the attraction of aggregation, are terms used to express the union of some bodies with certain bodies in preference to others; but, in the correct meaning of the active word attraction, there is not and cannot be any abstract power of the kind.

The pressure of media, the fitting forms of the uniting atoms, and the varied motions of which they are susceptible as agents and patients, are sufficient to explain all the preferences of union and separation. The facts detailed at Col. 179 sufficiently illustrate the necessary union of certain sets of atoms in preference to others.

If hydrogen in 100 cubic inches has but 2·118 matter, and 47·21432 motion, nitrogen 29·65 matter and only 3·37267, oxygen 33·888 matter and 2·9502 of motion, we can easily conceive their varied effects in various combinations, while it so happens that all their affinities are displayed while in motion as gases or as fluids. The coincidences are more remarkable when we consider the ratios of the velocities which between oxygen and nitrogen are *exactly* 7 to 8, in oxygen and hydrogen 1 to 16, and in nitrogen and hydrogen 1 to 14.

These more or less govern all bodies of which they are constituents.

Chemists give tables of affinities, amusing and often useful.

Thus it appears, by various experiments, that order of the affinity of oxygen for metals is manganese, zinc, iron, tin, antimony, cobalt, nickel, arsenic, bismuth, lead, copper, &c. to platina, mercury, silver, and gold. The order necessarily indicates the greater or less alkalinity of the metal, or in burning the varied degrees of hydrogen which they possess.

As all our experiments are in water (hydrogen and oxygen) or in air, (nitrogen and oxygen,) considerable difficulty arises in separating the action of these menstrua from that of the immediate agents of composition or separation. Heat or atomic motion also constantly varies and disturbs these affinities, as when alcohol is added to a solution of potass, the potass is precipitated, but if the alcohol is volatilized by heat, the potass again dissolves in the water; or when mercury is heated in one degree it fixes oxygen, and forms red precipitate, but in a greater degree the oxygen is regassified and the red oxide reduced again to pure mercury.

Untraced motion is, in fine, the necessary cause of all these affinities. On this doctrine the varied susceptibility of bodies to heat, or, their specific heat, or capacity for heat, as it is absurdly called, is a perfect illustration. If the results are to be relied on, and hydrogen gas receives motion with 4½ times the facility of oxygen, 27 times that of nitrogen, and 12 times that of air, these variations explain much. To which we may add the solubility or affinity arising from the atomic motion of water.

It would be practicable to follow out all these differences, and deduce the reason of all the affinities, but this is not the place for so theoretical an enquiry. Dr. Tho. Young carried these enquiries, as well as many others, to their limit of precision.

ELECTRICITY, is the phenomena which are presented when any disturbance or separation has taken place in the natural union of oxygen and nitrogen, or the motions of atoms, (called acid and alkaline) in gaseous bodies, or bodies becoming gaseous. The combination of their motions in certain proportions, as 3·5 nitrogen to 1 oxygen in the neutral atmosphere, is a natural law of fit and harmonious motions, and when this natural association is disturbed, the re-union is effected by a display of re-acting force, of which intervening bodies are the patients.

Sometimes, when some obstruction is presented to restoration, the body is scattered, torn in pieces, or destroyed. The intensity of the force is also such as to generate great atomic motion or heat, with light varied in colour by the constituents of the combustible affected or intervening. In general, restoration is effected through points which concentrate the action and reaction of large volumes or surfaces.

The unequal proportions in which acids and alkalies exist in all different bodies, and their respective tendencies to affect the atmosphere, and one another, create a general correlative disturbance of the equilibrium, and this difference and the restoration constitute, in part, the activity of the material world, and create nearly all the changes in the forms and appearances of bodies and matter.

Thus, when rocks of different degrees of constitutional acidity and alkalinity are in proximity, their effluvia combine electrically; then the union of the exhaling atoms of the rocks creates compounds, which constitute the oxides of metals, and, when deprived of their oxygen by sundry manipulations, are the minerals of arts and commerce, consisting as such of alkalies with an earthy base.

And these, restored to their oxide state, with an extra dose of oxygen, constitute the various salts derived from oxides.

Again, the oxides called alkalies containing more alkali than base, are converted into salts in like manner.

By a similar play of the acidifying oxygen and alkaline nitrogen between the lungs and the skin, or covering of animals, their heat is maintained, and their stomachic soil assimilated with their organic systems.

Then hydrogen, being decomposed from water by the roots of vegetables, fixes oxygen by an electric restoration at the surface and leaves; and the plant or tree is the intermediate product of that action and reaction.

In combustion we see the play of the same agencies. Hydrogen and carbon are excited and evolved, while oxygen is fixed by them, and its previous motion is then radiated as heat, while aqueous vapour is formed; and in some cases nitrogen is fixed and converts the ashes into an alkali.

Light is an impulsion around of the atomic excitement of the local process of combustion in the gas in which the process takes place.

Fermentation is the extrication of carbonic acid, and the generation and accumulation of hydrogen.

These several cases include the great processes of nature, and they are all founded either on electricity such as we display in our machines, and galvanic combinations; or on the same general principle of separating what nature combines followed by energetic restoration or silent action and reaction.

Exceptions, peculiarities, and modifications, might be discussed, but they do not form the simple general rule of nature.

Bodies are *electric* when they permit the excitement on one surface to display its contrary on their opposite surface, *i. e.* when they are susceptible of electric action.

Bodies are *non-electrics* when they permit no action to pass through them, and are the obstructors of the rectilinear action of electrics, as obstructing metals in electric air, which, by extension, become conductors.

Galvanism is the varied alkalinity of two proximate metal plates acted on by an intervening acid fluid.

Electrical action being a mere effect of disturbance of two elements or varieties of motion, is equal, mutual, reciprocal, and correlative between bodies; and there being no electrical fluid, there is no excess of it in one body, or deficiency in another; and no bodies which are electrical *per se*. It is always equally and simultaneously *negative*, and also *positive*, like light and shade, or like the arms of a lever, one up and the other down. No set of bodies are positive, and no other set negative, but any electric which is positive on either side must, with equal force, be negative on the other side.

This is not a work on electricity, and the details of that science are more amusing than useful: but to this extent it may be proper to disabuse the world of much execrable nonsense, propagated by ignorance or inadvertency, especially as electrical action is so influential in nature.

Half the surprises connected with electricity cease the moment it is announced that the positive is oxygen in elementary separation from nitrogen, and both simultaneously seeking re-union. All the phenomena yield to this theory. It removes every mystery, and enables us to reason on the phenomena with the same precision as though we saw the two elements in action. What are called conductors are mere obstructors of the disturbance, which disturbance in right lines pervades all electrics, and them only. But conductors and electrics exist in degrees, and hence the vast complication of phenomena.

Electricity and galvanism, in fine, are phenomena created by the play, or the action and reaction of the two sets of atoms, which in reciprocal motion compose the atmosphere. The intervention of matter obstructs their actions and reaction, and in various matter variously obstructs, so as, by varied resistance and facility, to produce and exhibit all the local and atomic phenomena of the organic bodies of which the matter consists.

In the two sets of atoms, there is nothing abrupt, and no sudden transition. Taking the prismatic spectrum as the guage, then the oxygen atoms commence at the red, or a little beyond the red end, and present a series of decreasing bulks, and increasing motions through the red, orange, and yellow, into the green; motion and bulk then having acquired a limit in equality, from the green we have then more motion and less bulk, till bulk fines off at the violet, and in black or negation. The green is the neutral ground between yellow and blue, each encroaching less and less from right to left, and left to right, so that the spectrum, in fact, exhibits all the gradations of optical and chemical action.

*Or*, we may conceive the two ends to be relatively an excess of large atoms, in small velocity, and of small atoms in great velocity, and the green to be their mean. *Or*, the atoms to be of various sizes in the same velocities; or, of the same size with different velocity. Whichever it be, this variety is the cause of the varied effects, and, on one of the hypotheses, a simple mechanical principle operates. The oxygen end is what we call positive electricity, and the nitrogen end, or hydrogen, is the negative electricity. Atomic life is produced by their contest to arrive at equality on the surfaces of bodies.

Electrical disturbance arises thus:— The atmosphere is a compound of oxygen 1, and nitrogen 3·5, the atoms of each being co-extensively distributed. If then any concentration of either is by suitable excitement made to take place in any electric space, or nonconductor, a radiation takes place of that species, whether nitrogen or oxygen, and a sphere of its action is generated around.

But the other principle, nitrogen, or oxygen, not being involved in the same action, seeks a restoration of the original condition of union, and on any distinct obstructor, or conductor, being placed opposite the centre of the other disturbance, it concentrates the counteracting force, and becomes in that spot the centre of a radiation of its own kind, in a sphere equal to the other.

Thus there are two diffused spheres, not concentric, each with its centre, just beyond what is called the striking distance, and each directed towards a different centre at a few inches, or, when great volumes are concerned, a few feet, or yards apart. The reunion of the centres is the restoration, whether it take place at the place of excitement, or is made to travel by a double line of conductors, and is then reunited at any distance at points called poles.

The excitement itself, or that which concentrates a volume of the oxygen, or nitrogen force, by separating it from the general diffusion, is any oxygenous action calculated to entangle nitrogen, or any nitrogenous entangling oxygen. Then the second, or opposed force, is generated either by a body placed on purpose like a prime conductor, or the body of the operator moving towards the seat of primary excitement, by which the body becomes in an opposite state, and creates a new sphere of action in that opposite state.

The spheres of action and reaction appear on all the distant walls, the bell-wires, &c. &c.; but when the centres are brought together the spheres reunite, and the former equilibrium of the two gases is restored.

Electricity is, therefore, an oxygen, or a nitrogen concentration of either, within a nonconductor, or electric. The other power, the nitrogen or oxygen, then respectively seek reunion, and if a conductor, or obstructor, is interposed, the correlative force concentrates on that as the best and nearest approach. The action and reaction between these centres of oxygen and nitrogen spheres then is electricity.

If either, or both, has its conducting or obstructing surface extended, or increased, the action spreads on it, or is conducted; and if the other is also spread, any nearest point becomes its centre, and at that point, as well as at the original point, the centres may be reunited, and the spheres, then collapsing, cease to display further phenomena.

Conductors are conductors because they are impervious to the action, just as lead pipes are conductors of water because they receive none of it.

Electrics are called non-conductors, because they receive, transmit, and exhaust or localize the correlative action on the spot, and, therefore, will not conduct it. Thus air permits spheres of action, glass generates its second sphere, &c. the local massive action preventing the lateral diffusion in parts, which takes place when bodies are in contact, which permit no action in or through them, as metals, water, &c.

In other words, electricity is the separation of the acid and alkaline principles of the air, and most of its phenomena arise from their reunion, and the restoration of the disturbance.

The variety of phenomena, and the relative electrical power of bodies, arise from bodies not being either absolute electrics or absolute obstructors, or conductors, but only so in various degrees; so that bodies relatively to one another may be either electrics or conductors. Thus, in galvanism, the plates would be within striking distance, and restore themselves, but we present wires, which are better conductors, and then restore the disturbance in their poles by bringing the poles near enough. The distance of the generators is, however, so l ttle, that we no doubt lose much force, get little more than the lateral action, and no radiation of sparks, and none of the shewy phenomena of aerial electricity. Intensity is, however, inversely as the square or cube of the distance of the generators, and, hence, the intensity and chemical action of galvanism.

In the action of an acid upon a metal, the acid exhibits the positive, and the metal the negative electricity.

Delarive has lately proved that a galvanic pile exerts no action in a vacuum, or in a medium not in chemical reaction with its parts; and that the phenomena so much depend on heat, or atomic motions, that the same metal acts and reacts if one plate is rough and another polished, and even at a distance, in air, displays a measurable quantity of electricity.

The effect of the two electricities on heat is striking. If a candle be set two inches from the positive and negative balls, and the excitement be continued, the negative ball grows very hot, and the positive continues cool. It would hence appear, that the oxygen brush conveys and directs the heat, or mobile atoms of the flame, to the negative ball as a receiver, and that the mobile atoms, or heat, become entangled in the current of the circuit. A pith ball in a circuit is carried in like manner to the negative ball by the brush.

As all electricity is restoration, and common electricity is one stroke, and galvanism a continued succession of strokes, so the phenomena of one stroke in great quantity of power is different from the unremitting succession of strokes, however feeble. Hence, common electricity disperses bodies, and galvanism melts and vitrifies them with slight propulsion. The one is diffused and massive, the other atomic and chemical, while the intensity is inversely as the distance of generation; great between, or near galvanic plates, less in glass plates, and still less in aerial plates or common sparks.

Electrical discharges through wires, in enclosed vessels, are converted into powders of different colours, and the air is deoxydated, proving that action and reaction of the currents merely heat and comminate the wires, and that the oxydation is derived solely from the air. If the discharge is made through wires laid on white paper, the paper is beautifully marked of different colours, and glass is permanently marked when it is substituted for paper.

When a kite is used for electrical purposes, brass or gold thread is twisted with the string, which ends with an apparatus so insulated as that an excess may go into the ground. A cord is then extended to a small insulated conductor for experiments. So also with elevated conductors. A clear atmosphere indicates as much electricity as an ordinary cloudy one, but thunder clouds in general afford strong positive electricity, often dangerous.

Electrical amalgam is made by melting equal parts of tin and zinc in a crucible, and pouring them on two parts of mercury in a wooden box, which is to be shook till they are cold. Then pulverize in a mortar, and form it into paste with hogs' lard or oil. Some merely work together tin foil and mercury, and apply it soft on the rubber.

ELECTRO-NEGATIVE AND ELECTRO-POSITIVE SYSTEM. This was a theory of Davy, who erred in all his ideas about electricity, which, correctly considered, is merely the re-union of separated spheres of oxygen and nitrogen, whose centres are the place of excitement. Davy's theory applies to galvanic action at poles, where the centres of spheres are brought. Nitrogen and its compounds go to the negative pole in a certain order, and oxygen and its compounds to the positive, in their order. And as Sir H. Davy inferred that negative *attracted* positive, &c. and *vice versa*; so he made one set *positive* and the other inherently *negative*. This accident, at the poles, does not, however, imply any positive electricity inherent in one set, or negative in the other; since it is the mere mechanical effect of the local force of the restoration.

We call positive electricity the

most powerful, and we see it in the brush; and, on the contrary, we see the patient character of the negative in the star. We believe the two to be actions of oxygen positive and nitrogen negative. If a body, placed between the poles, is oxygen and nitrogen, then the oxygen from the positive pole would carry with it the hydrogen to the negative pole; and the hydrogen from the negative side would carry with it the oxygen to the positive pole. But, on that account, the bodies themselves have *no electricity*; and it is absurd to say, therefore, that oxygen, &c. &c. are positive, and hydrogen, &c. &c. negative. It cannot be too often repeated, nor be too strongly impressed, *that electricity is a mere relative or correlative Effect, and that in no case can there be positive electricity without parallel and opposed negative*, and *vice versa*. It is correlative, simultaneous, opposed, or contrasted, action and reaction.

It is, therefore, a fundamental objection to the electro-chemical theory of Davy, that electricity is a relative double Effect, and not a positive, inherent, isolated, Power. It is positive in A, *because* also negative in B; and not positive or negative in either, unless it is the contrary in the other; while both must be in juxtaposition.

The electro-chemical theory asserts that oxygen, chlorine, bromine, and iodine, are always negative; and other simple bodies positive. Thus, potassium is alleged to be positive, and then oxygen being negative, this explains their union. Heat is said to exalt the electricities, &c. &c. and, of all bodies, hydrogen is the most positive; carbon, phosphorus, sulphur, and nitrogen, with others, follow in degree. We think the power altogether irrelevant, and rather ascribe positive electricity to oxygen, and negative to nitrogen and hydrogen, as causes of it, and not as patients.

The distinctions (says Mr. Connell, a modern chemist,) between the subordinate classes into which simple bodies have been divided, are evidently vanishing before the progress of discovery, and we seem fast approaching to the establishment of an unbroken chain of elementary bodies, differing from one another by gradations of qualities which are continually approximating to each other. The discovery of selenium nearly destroyed the class of metals as an exclusive division. That of lithia, and its metallic base, went far to annihilate the distinctions between alkalies and alkaline earths and their respective bases; and it is extremely probable that between iodine and sulphur one or more bodies will one day be found to exist, combining many of the qualities of both these substances, and serving to unite them more closely.

ELECTROPHORUS, (The) is an excited non-electric plate, either of equal parts of rosin, shell-lac, and turpentine, or of glass, or mica, coated on the under side, and connected with the ground; having a moveable coating on the upper side, and a handle to raise it, or to carry it into contact. It exactly displays all the phenomena of a charged plate of glass, with and without the coating. The under side, or under side and its coating, being electrical and negative, and the upper side is the same. But, as *the excitement is in the electric and not in the coating*, which merely connects the whole surface of the electric, so when the upper coating is lifted off, the excitement continues in the electric, and the coating by induction becomes positive. In other words, the coating, when lifted off, coats the positive space *above* the negative electric, and, therefore, displays positive electricity. It is a very cheap and portable electrical exciter, and a jar may be charged by 20 or 30 of its sparks, and a strong spark may be given by connecting the lower coating with the upper when lifted up. The spark is the union *of the nitrous oxide of the atmosphere with the hydrogen of the electric.* Its action may be illustrated by slipping a coating of tin-foil on the upper surface, when the former is raised, and a strong spark will then pass between the two.

ELECTUARIES, somewhat resemble confections, but with less sugar. The chief are *lenitive electuary* for habitual costiveness, made of 8 senna-leaves, 4 coriander-seeds, 3 liquorice-root, 16 figs, 16 prunes pulp, 8 tamarinds pulp, 32 sugar, and 48 water. Mingle the powders of the two first. Boil a fourth in the water with the figs and liquorice to one half and strain, and evaporate to 18. Add the sugar and prunes, and then the dry powder, 1 to 4 drs. at bed-time. *Electuary of cassia* answers the same purpose, and is made of half a lb. of cassia pulp, 2 oz. of manna, 1 oz. of tamarind pulp, and half a lb. of syrup of oranges, or roses.

ELEMENTS, universal principles and simple agents of phenomena, varied in relative power by the size, form, and motion of the atoms. The ancients reckoned four, air, fire, earth and water. The moderns except to this, because air is two elements, oxygen and nitrogen; fire is a mere *effect* of the play or reunion of oxygen and hydrogen; earth is carbon, nitrogen, and oxygen, or metal when without oxygen, and oxyde or earth with it; and water a compound of oxygen and hydrogen.

But then the moderns call other compounds elements, as oxymuriatic acid, or chlorine, iodine, bromine, &c., made from marine alkalies and oxygen. Also phosphorus, sulphur, metals, &c. which by flaming indicate clearly that they possess hydrogen in their composition. And they call all bodies elements, which their arts will not decompose.

Logically, the moderns, in this respect, are not more correct than the ancients.

We seem, in spite of some peculiarities, which do not create the rule, to be obliged to regard hydrogen as the element of activity; and carbon, as the element of passive combination. And nitrogen and oxygen, as primary formations from these—one producing all alkalinity, and the other all acidity. On this superstructure all other bodies may be raised, and, in fact, are synthethically raised.

In natural synthesis, some extreme subdivisions produce effects which art cannot always imitate; and then the tests which decompose our artificial products do not always reach natural products of time and subdivision.

Logically, then, there are but two primary elements, hydrogen and carbon; and two secondary, oxygen and nitrogen. Others, formed out of these, may be called tertiary elements.

In another sense, there may be but *one* element, carbon; and the finest particles of this may form hydrogen with *motion*—and hence the matter carbon, with motion, may be the primitive and universal agent of all materials, compounds, and organic phenomena.

Modern elements are certain gases, called supporters of combustion, which unite with other elements, as hydrogen, nitrogen, carbon, phosphorus, sulphur, &c., and form acids; and with potassium, sodium, calcium, &c. they form 7 alkalies, with others forming 6 earths, and with 18 metals forming oxides. The chemical test of an element is, present inability to decompose it, and the analogy of its compounds; but the philosopher, who looks at nature on its own great scale, and observes the vast operations of oxygen, hydrogen, nitrogen, and carbon, will long hesitate to admit into the same rank the odd compounds which chemists discover in the holes and corners of retorts; and will regard them as curiosities and sports of nature's laboratory, rather than as essentials of the machinery of the universe. Nothing can be more amusing than the pursuit of these bodies in their compounds and changes, and they are often useful. Common sense, and the popular acceptation of the word element will, however, be incredulous, even as to such bodies as sulphur, phosphorus, &c. &c.

The elements which anciently were fire, air, earth, and water, are now regarded as nearly 50 or 60 in number, it being considered that that number are undecomposable.

Universality appears, however, to be a necessary characteristic of the term element—such as oxygen, which, with nitrogen, forms air, and with hydrogen water—or carbon, which, with those, forms all solid bodies. An isolated substance, with kindred properties to either, is rather a *lusus naturæ*, than an element; and there are such differences as warrant the suspicion that in each case they are mere compounds, in which the general element is masked.

If it is alleged that the combustion of the metals do not form water, it ought to be shown that the proportions are such as ought to form water.

Nor have chemists taken into account the effects of MOTION in varying phenomena. This is an element inferior to neither and as general as either; but lost sight of in books. Acids and alkalies lose all their potency when concrete or unmoved; and it is their mobility, as fluids or gases, that confers their antagonist powers of forming new products. The principle of definite proportions proves mechanism, and all mechanism is matter in motion, accordant with figure and number.

ELIXIR OF VITRIOL.—To water add oil of vitriol, so as to give a grateful acidity. It is used for gargle, to check salivation, by workmen and servants to clean copper and iron work; also, as a cheap acid in punch, or acid stews, instead of lemons, and to give strength to poor vinegar.

EMBROCATIONS. Mix 1 ℔. of spirit of mindererus with 3 oz. of spirits of wine.—*Or*, mix ½ oz. of camphor with ½ ℔. of spirits of wine, with 6 oz. of distilled vinegar and 3 oz. of water. *Or*, mix 3 oz. of white soap with 12 oz. of spirits of wine, 4 oz. of spirits of hartshorn, and 1 oz. of camphor.

EMERALD, is a well-known gem, of pure green colour, somewhat harder than quartz. Its natural form is either rounded, or that of a short six-sided prism. The most intensely coloured and valuable emeralds that we are acquainted with are brought from Peru. They are found in clefts and veins of granite, and other primitive rocks, and often grouped with the crystals of quartz, felspar, and mica. In value they are rated next to the ruby, and, when of good colour, are set without foil, and upon a black ground, like brilliant diamonds. Emeralds of inferior lustre are generally set upon a green gold foil. These gems are considered to appear to greatest advantage when table-cut and surrounded by brilliants, the lustre of which forms an agreeable contrast with the quiet hue of the emerald. They are sometimes formed into pear-shaped ear-drops; but the most valuable stones are generally set in rings. A favourite mode of setting emeralds, among the opulent inhabitants of South

America, is to make them up into clusters of artificial flowers on gold stems. The largest emerald that has been mentioned, is one said to have been possessed by the inhabitants of the Valley of Manta, in Peru. It is recorded to have been as big as an ostrich's egg, and called the *mother of emeralds*. The Oriental emerald is a variety of the ruby, of a green colour.

EMERY, a very hard mineral, of blackish or bluish-gray colour, chiefly found in shapeless masses, and mixed with other minerals. It contains about 80 parts in 100 of alumine, and a small portion of iron, is usually opaque, and about four times as heavy as water. In hardness, it is nearly equal to adamantine spar, and this property has rendered it an object of great request in various arts. It is employed by lapidaries in the cutting and polishing of precious stones; by opticians, in smoothing the surface of the finer kinds of glass, preparatory to their being polished; by cutlers and other manufacturers of iron and steel instruments; by masons, in the polishing of marble; and, in their respective businesses, by locksmiths, glaziers, and numerous other artizans. For all these purposes, it is pulverized in large iron mortars, or in steel mills; and the powder, which is rough and sharp, is carefully washed, and sorted into five or six different degrees of fineness, according to the description of work in which it is to be employed.

EMERY CLOTH.—Paper is so brittle that it will not hold together after having been used a little while, and this happens just when its quality as a polisher is the best, from the coarser grains of sand or emery having been rubbed off. By substituting the cheapest kind of calico for paper, an article has been produced, the durability and utility of which far more than compensate the additional cost. The sand, pounded glass, and emery, are to be sorted by washing over in the usual way, and then are to be dried for use.

EMETIC, is that which is capable of exciting vomiting. Emetics are medicines which excite the stomach to discharge its contents. They are ipecacuana, tartarized antimony, sulphate of zinc, tobacco, mustard, &c. but now superceded by the stomach-pump, with warm water.

EMETINE, is a peculiar vegetable principle, obtained from the ipecacuana-root. It is obtained by digesting the root first in ether, and then in alcohol. The alcoholic infusion is evaporated to dryness; and to the residuum, redissolved in water, acetate of lead is added, which produces a precipitate. The precipitate is washed, diffused in water, and decomposed by a current of sulphuretted hydrogen gas. Sulphuret of lead falls to the bottom, and the emetine remains in solution. By evaporating the supernatant fluid, this substance is obtained pure. In a dose of half a grain, it acts as a powerful emetic, followed by sleep.

EMMENAGOGUES, are medicines to promote regularity in menstruation. Black hellebore, savin, madder, polygala senega, ergot of rye, oil of turpentine, and cantharides, have been commended for this purpose.

EMULSIONS, imperfect solutions of the fixed vegetable oils in water. They are obtained by rubbing the seeds affording these oils with water, to which a little sugar is added.

ENAMELLING, is the art of variegating with colours laid upon or into another body; also, a mode of painting, with vitrified colours, on gold, silver, copper, &c. and of melting these at the fire, or of making curious works in them at a lamp. Enamels are vitrifiable substances, and are usually arranged into three classes; namely, the transparent, the semitransparent, and opaque. The basis of all kinds of enamel is a perfectly transparent and fusible glass, which is rendered either semitransparent or opaque, by the admixture of metallic oxides. The art of colouring glass seems to be of nearly the same antiquity as the invention of making it; which is proved, not only from written documents, but likewise by the variously-coloured glass corals with which Egyptian mummies are decorated.

*White* enamels are composed by melting the oxide of tin with glass, and adding a small quantity of manganese, to increase the brilliancy of the colour.

The addition of the oxide of lead, or antimony, produces a *yellow* enamel; but a more beautiful yellow may be obtained from the oxide of silver.

*Reds* are formed by an intermixture of the oxides of gold and iron, that composed of the former being the most beautiful and permanent.

*Greens*, *violets*, and *blues*, are formed from the oxides of copper, cobalt, and iron; and these, when intermixed in different proportions, afford a great variety of intermediate colours.

Sometimes the oxides are mixed before they are united to the vitreous bases. All the colours may be produced by the metallic oxides.

The principal quality of good enamel, and that which renders it fit for being applied on baked earthenware, or on metals, is the facility with which it acquires lustre by a moderate heat, or cherry-red heat, more or less, according to the nature of the enamel, without entering into complete fusion.

Enamels applied to earthenware and metals possess this quality.

Enamels are executed upon the surface of copper, and other metals, by a method similar to painting.

The art of ENAMELLING has long been known and practised, but its application among potters is of a comparatively recent date. And, at present, no printed volume details the particulars of the processes constantly employed. The following remarks, however, may be received with confidence.

The glaze of the article to be enamelled requires to be of a certain kind, for the colour to answer well; for when that is soft, or contains much oxide of lead, the enamel colour needs much less flux; the softening of the glaze during the baking allowing the metallic particles to readily become embedded therein; not, however, without some kind of change, for the dilution with the glaze will frequently cause a design, apparently finished, to be a mere sketch when taken from the muffle.

The lead in the glaze acts most perniciously on the colours, when they are preparations of iron. Indeed, all the disadvantages of the art are found to have this origin.

The fleeting nature of many of the colours renders absolutely requisite the repeated exertions of the artist, and care of the foreman, that the whole ornament may appear perfect in all its tints and delineations. When properly performed, however, while the design will possess a remarkable softness in colouring, it will likewise possess an unfading brilliancy.

Whether the body of the ware be very hard or very soft; whether the glaze be principally lead, boracic acid, or felspar; the colours must be fluxed so as to become a part of the glaze itself, at a degree of heat in the baking much below that required to bake the *bisquet* of the article. And, also, that those which are first employed may not sustain injury from the subsequent bakings to give the whole design all its effect and elegance. The repetition of the artists' efforts are indispensable to the finished appearance of many designs; yet, the softness of the glaze in the baking causes the whole to be of as smooth a nature as any other kind of paintings. The alkaline glaze, more readily than any other, imbibes the base of the colour; and its softness is only excelled by that of felspar; which latter, in the baking, becomes more porous without softening; yet the brilliancy of the colour is scarcely at all affected.

When the colours have either potass or soda in their composition, the extreme heat of the baking volatilizes the alkali, leaving the metallic base without a medium by which it can be fixed. Those colours, however, which will fuse by the same heat as bakes the glaze, when mixed with a proper solvent, never scale off, nor lose their brilliancy.

The enamel colours are oxides of metals, or calcined minerals chemically combined with a perfectly transparent and fusible glass; in some instances, one or two of the former are mixed prior to being fused with the vitreous medium.

Gold is used for purple and rose colours, and a beautiful lustre, cobalt for blue; copper, for greens and blacks; antimony for yellow; umber for black and brown; platinum, for steel lustre; manganese, for violet; chrome, for cornelian-red, and pomona-green; and sulphate of iron, in different states, for red, brown, and black. And the mixture of these, among each other, produces great variety of colours.

After being fused properly, each colour is ground very fine, next well dried, and then applied to the ware, by hair-pencils and spirits of turpentine. When a *ground* is requisite, a fluid of well-boiled linseed-oil, a little red oxide of lead, and also a little turpentine, is laid very even on the ware, and with soft cotton the very fine enamel colour is dusted on the fluid. In some instances, a broad hair-pencil is employed.

The lustres are least liable to injury by baking; but the rose colour, cornelian red, gold for burnishing, and pomona green, are protected by a central situation, and around them in the kiln are dispersed articles with colours of a less destructible nature.

ENCAUSTIC PAINTING.—Pliny distinguishes three species: 1. that in which the artists used a style, and painted on ivory or polished wood, for which purpose they drew the outlines on a piece of the aforesaid wood or ivory, previously soaked or imbued with some colour; the point of the style, or stigma, served for this operation, and the broad end to scrape off the small filaments that arose from the outlines; and they continued forming outlines with the point till they were finished. 2. The next manner appears to have been one in which the wax, previously impregnated with colour, was spread over the surface of the picture with the style, and the colours thus prepared were formed into small cylinders for use. 3. The third manner was with a pencil, in wax liquefied by fire. By this method the colours acquired a considerable hardness, and could not be damaged, either by the heat of the sun or the effects of sea-water.

ENGRAVING.—The kinds of engraving are:—

1. Engraving in strokes with a point, the plate being covered with a ground,

and the strokes afterwards corroded with aqua fortis.

2. In strokes, with the graver alone, unassisted by aqua fortis. In this instance the design is traced with the *dry-point*, and the strokes are cut in the copper by the graver, used for card-plates, &c.

3. In strokes, which are first etched with aqua fortis, and then finished with the graver.

4. In dots, without strokes, which are performed with the point upon the wax or ground, and then bitt-in with aqua fortis, as in etching; but they are afterwards harmonized and softened with the graver, by making additional dots.

5. In dots, which are first etched as the foregoing, but afterwards harmonized by the dry point, performed by a little hammer, called stippling.

6. In mezzo-tinto, which is performed by covering the plate with a strong dark ground, or deep shade, by means of a toothed tool, and corroding the dots with aqua fortis. The parts which are to be light are then rendered more or less smooth by the scraper and burnisher.

7. In aqua tinta, in which the outline is first etched, and the plate afterwards corroded.—*Partington.*

The implements employed in engraving on copper or steel, are few and simple; they consist of variously-formed gravers, a scraper, a burnisher, an oil stone, a sand bag, an oil rubber, and some good charcoal.

*Gravers* are small bars of steel, of a square or lozenge form, and, with the short handle into which they are fitted, are about five inches long. One of the angles of the bar is always on the under side of the instrument, and the point is formed by bevelling the end from the uppermost angle. The square form is used for broad strokes, and the lozenge for fine ones. The upper end of the handle is a kind of knob, with the under side of it cut off, in order that the instrument may be used with the steel nearly in a horizontal position. The goodness of the steel, as well as its temper, is of consequence. If a graver will not make a mark upon common window glass, it is too soft. Towards the extremity, the graver should bend upwards a little, in order that the point may be more readily prevented from digging into the copper. The bevelled part, and the two sides which form the edge, should be rubbed upon the oil-stone in such a manner as to be quite flat. To take off any bur which may be occasioned by the whetting, the point is usually struck into a piece of box, or any other close-grained wood; and its sharpness is tried upon the nail; if it will cut the nail without leaving any jagged edge, it is fit for use.

Great care is required to whet the graver nicely, particularly the belly of it, the two angles of which are to be held next the plate, flat upon the stone, and the artist must rub them steadily till the belly rises gradually above the plate, so that when you lay the graver flat upon it you may just perceive the light under the point, otherwise it will dig into the copper, and then it will be impossible to keep a point, or execute the work with freedom. In order to this, keep your right arm close to your side, and place the fore-finger of your left hand upon that part of the graver which lies uppermost on the stone. When this is done, in order to whet the face, place the flat part of the handle in the hollow of your hand, with the belly of the graver upwards, upon a moderate slope, and rub the extremity, or face, upon the stone, till it has an exceedingly sharp point, which may be tried upon the thumb-nail.

When the graver is too hard, as is usually the case when first used, and may be known by the frequent breaking of the point, the method of tempering it is as follows: heat a poker red-hot, and hold the graver upon it, within half an inch of the point, till the steel changes to a light straw-colour, then put the point into oil to cool: or, hold the graver close to the flame of a candle till it be of the same colour, and cool it in the tallow, but be careful, either way, not to hold it too long, for then it will be too soft; and in this case the point, which will then turn blue, must be tempered again. Be not too hasty in tempering, for sometimes a little whetting will bring it to a good condition when it is but a little too hard.

The *dry-point*, or needle, consists of steel wire, with a small cylindrical handle, or it may be of a sufficient length and thickness to be held without a handle. It should be tempered like a graver, and have a fine conical point; and should be entirely free from any angular edge, otherwise it cannot be drawn upon the copper in every direction.

The *scraper* and *burnisher* are frequently made in the same piece, one at each extremity of a piece of steel, which is about seven inches long. The scraper has nearly the form of a triangular pyramid with the point cut off. It is used to remove the bur occasioned by the dry-point, and on similar occasions; any of its edges are used in this way. The burnisher is a cone, except that it is a little convex on the side; it is used to rub out scratches which appear on the plate, and to lessen the force of a line which has been cut too deep.

The *oil-stone* should be a piece of the best Turkey hone used with olive-oil.

The *cushion* is a bag of leather filled with sand. It should be about three inches thick, and always less than the plate to be engraved.

*Parallel rulers and compasses* will be required as in drawing; the former should have a brass edge; and the latter should be entirely made of steel, with a spring instead of a joint at the head, and with a screw to regulate the opening of the limbs, called *dividers*.

By the *moveable table* the copper-plate is attached to a moveable board, by twelve screws, so that the board that supports the plate may readily be inclined at any given angle by means of the resting table and support. In the centre is placed a strong iron axis, on which the plate is made to revolve, and to diminish the friction that would otherwise arise from the weight of a large plate, the board is supported by friction rollers. By employing a number of holes in the board beneath, the centres are readily changed for the various lines that may be required.

The graver is the only tool that can be depended upon in finishing small subjects which require neatness. The best manner of preparing it is, by changing its situation in the handle, so that the belly part of it, which was lowermost, becomes uppermost; then, by turning the handle in the hand, the point acts upon the copper from a greater elevation, which is preferable; as dots only, and not strokes, are required, the tool is managed in this position with much greater ease and freedom. This part of the operation consists only in covering the copper with dots, in a manner, lighter or heavier, proportionate to the colour required. When one covering of dots is scraped off, another must be inserted, and so on; by this repetition a proper grain, and sufficient masses of shade are procured.—*See* ETCHING.

In large subjects, and also in those where a general effect only is wanted, and great exactness is not required, some persons use various tools for facilitating their work, such as wheels having single or double rows of teeth at their edges, cradles resembling a mezzotinto grounding-tool (but made with teeth), and others constructed according to their own fancy.

To clean engraved strokes, they should be washed with a little spirit of turpentine; if the dirt is of long standing, soap-lees poured on the plate while it is heating will be very effectual in clearing away the dirt. But it must be immediately washed off with plenty of cold water, otherwise it will injure the work; it is also too strong for mezzotinto plates, unless used very carefully, and not suffered to continue long.

To trace against the light, for engravers' purposes, hold the drawing you wish to copy against one of the panes of the window, or have a pane of glass put in a frame, and fitted up like a music-stand, with a candle behind it. Lay your paper over the drawing, and you will see all the lines of the original distinctly through it, by which means you can easily trace them with a pen or black-lead pencil.

To make the tracing paper, mix equal parts of oil of turpentine and drying-oil, and with a rag rub it over hard tissue-paper, or any very thin paper. Hang it up to dry for a day or two, and it will then be fit for use. Lay this over the print or drawing you intend to copy, and you will see every line distinctly through, so that you can go over them with the black-lead pencil. If you wish to do it in ink, you must mix a little ox's gall with the ink, to make the paper take it, on account of the oil.

To transfer to the plate an exact copy of the design, heat the plate in an oven, or hold it over one or more candles, till it will melt white wax, a piece of which should then be rubbed over it, and allowed to spread till it forms a thin uniform coat over the whole surface; after which the plate may be left upon a table till it is cool. In the mean time, take a piece of transparent paper, and fastening it upon the original design, in the usual manner for tracing, draw the whole of the outlines in the most accurate manner with a black-lead pencil. The outline, thus sketched, may be turned down upon the white wax with which the plate is coated, and upon its being subjected to the action of a press, or kept between several thicknesses of paper, under a heavy weight, for an hour or two, on taking it out the lines on the transparent paper will be found to be transferred to the white wax on the plate. The pencil-marks on the wax being now traced with a fine steel point, so as just to touch the copper, the wax may be melted off, and a perfect outline of the design will remain on the plate. When any small subordinate part of a design is to be transferred, the transparent paper is merely held on the plate, and rubbed on the back with the burnisher instead of pressing.

*To enlarge and contract by squares.*—Divide the sides of your original with a pair of compasses into any number of equal parts, and rule lines across with a black-lead pencil from side to side, and from top to bottom. Then having your paper of the size you intend, divide it into the same number of squares, either larger or less, as you would enlarge or contract it. Then placing your original before you, draw, square by square, the several parts, observing to make the part of the figure you are drawing fall in the same part of the squares in the copy as it does in your original. To prevent mistakes, number the squares both of the original and copy.

To prevent the necessity of ruling across the original, which in some cases may injure it, take a square pane of crown glass, and divide its sides, and also its top and bottom, into equal parts: then from each division draw lines across the glass with lamp-black ground with gum-water, and you will divide the glass into squares. Then lay the glass upon the original which you wish to copy, and having drawn the same number of squares upon your paper, proceed to copy into each square on your paper what appears behind each corresponding square of the glass. Instead of a glass, an open frame with threads stretched across will answer the same purpose.

The improvements introduced by Perkins are of considerable importance. A steel plate is engraved or etched in the usual way; it is then hardened. A cylinder of very soft steel, of from 2 to 3 inches in diameter, is made to roll backwards and forwards on the surface of the steel plate, until the whole of the impression from the engraving is seen on the cylinder in alto-relievo: after this cylinder has been hardened, it is made to roll backwards and forwards on a copper or soft steel plate, and a perfect fac-simile of the original is thus produced of equal sharpness.

*Engraving on Steel.*—To decarbonate the surfaces of cast steel plates, cylinders, or dies, by which they are rendered softer and fitter for receiving designs, pure iron filings are used. The stratum of the steel decarbonated should not be more than three times the depth of the engraving. It is to be exposed in a cast-iron box for four hours in a white heat. A thickness of half an inch of pure iron filings should cover or surround the surface. The box is to cool very slowly, by shutting off air, and covering it with six or seven inches of fine cinders. Each side of the steel plate must be equally decarbonated, to prevent its springing or warping in re-hardening.

The best cast-steel is preferred; and more for plates, when intended to be decarbonated; or rendered sufficiently soft to receive impressions, or designs, and previously to being printed from, it should be again carbonated, or reconverted into hard steel. To effect the carbonization, or the re-conversion into steel, a suitable quantity of leather is to be converted into charcoal, by exposing it to a red heat in an iron retort. Then take a box made of cast-iron, of such dimensions that the intermediate space between the sides and the plate may be about an inch, and this box is to be filled with the powdered leather charcoal, and placed in a furnace, and the heat gradually increased till the box is above a red heat, and it must remain till all the evaporable matter is driven from the charcoal. Then remove the lid from the box, and immerse the plate, to be hardened, in the powdered charcoal; so that it may be surrounded of uniform thickness. The lid being replaced, the box, with the plate, must remain in the same heat for three, four, or five hours, according to the thickness. Then take it from the box and immediately plunge it into cold water in a vertical position, in the direction of the length. To render it fit for use, it is the common practice to heat the steel again, to reduce or lower its temper, and the future degree of hardness, or temper, is indicated by changes of colour upon the surface. During this heating a succession of shades is produced, from pale straw colour to deep blue. But, it is found, that, on plunging the heated steel into cold water, and suffering it to remain there *no longer than is sufficient*, it almost entirely removes the risk of cracking or breaking. All this can only be learned by actual observation, as the workman must be guided by the hissing or singing noise which the heated steel produces in the water while cooling. A varying sound is observed, and it is at a certain tone before the noise ceases, that the effect is produced. "The only directions," says Mr. Perkins, "which can be given, whereby the experimentalist can be benefitted, are as follow: namely, to take a piece of steel which has already been hardened by remaining in the water till cold; and, by the common method of again heating it, to let it be brought to the pale yellow, or straw colour, which indicates the desired temper of the steel-plate to be hardened by the above process; as soon as he discovers this colour to be produced, to dip the steel into water and attend carefully to the hissing, or, as some call it, singing noise, which it occasions; he will then be better able, and with fewer experiments, to judge of the precise time at which the steel should be taken out. It is not meant," he says, "to be understood, that the temper indicated by a straw colour is that to which the steel plate, cylinder, or die, should be ultimately reduced; because it would then be found too hard; but merely that the temperature which would produce that colour, is that by which the peculiar sound would be occasioned when the steel should be withdrawn from the water for the first time. Immediately on withdrawing it from the water, the plate must be laid upon, or held over a fire, and heated uniformly, until its temperature is raised to that degree at which tallow would be decomposed; or, in other words, until smoke is perceived to arise from the surface of the plate, after having been rubbed with tallow. The steel plate, cylinder, or die, must then be again plunged into water, and kept there until the sound becomes somewhat weaker than before. It is then to be taken out, and heated a second time to the same degree, by the same rule of smoking tallow; and the third time plunged into water, till the sound becomes again weaker than the last. Expose it a third time to the fire as before; and, for the last time, return it into the water and cool it; after it is cooled, clean the surface of the steel plate, cylinder, or die; and, by heating it over the fire, the temper must be finally reduced by bringing on a brown, or such other lighter or darker shade of colour, as may best suit the quality of the steel, or the purpose to which it is to be applied." This is applicable to the working of steel in razor and scissors-making, as practised at Sheffield, Birmingham, and Warrington.

Engraving to imitate *chalk drawings* is a method of etching in dots. The preparation of the plate, laying the ground, tracing the subject, &c. is the same as in etching. The principal difference is, that, instead of lines, as in etching, the drawing, shadows, &c. consist of a mixture of varied and irregular dots, as freely as can possibly be done, more or less soft, so as to resemble the grain produced by the chalk on paper. For every stroke of the chalk may be considered as an infinite number of adjoining points, which are the small eminences of the grain of the paper, touched by the chalk in passing over it. The plate being prepared, and the ground laid as in etching, the drawing to be imitated may be counterproved on the ground of the plate. If this cannot conveniently be done, black-lead pencil, or red chalk, must be applied to varnished or oiled-paper; by which means all the traces of the drawing may be transferred to the ground. The outlines of the drawing must be formed in the etching by points, which will create dots, whose size and distances must be determined by the quality of the strokes of the original drawing.

*Engraving on wood.*—The wood most proper for engraving upon is *box-wood*, which should be cut to the height of printing types, by slices from the trunk of the tree, cut at right angles to the axis. This is done in order that the engraving may be executed on the end of the wood, as the graver will not, in all directions, make a smooth stroke upon any other side of the wood, nor would the work be so durable, if the fibres did not stand perpendicularly, while the block would be more liable to warp. The piece of wood being planed very smooth, the design is drawn upon it with a black-lead pencil; then every black line which the engraving is to exhibit, is to be left untouched, but all the intermediate spaces are to be cut out with the square or lozenge gravers, used for copper, or with tools of various sizes, with handles like gravers, and the same length, but shaped like chisels and gouges. In this process it is obvious that manual dexterity is the main requisite.—*Parkinson.*

*Engraving upon glass* is effected by fluoric acid, instead of nitric acid.

The strong varnish used by engravers is found to answer pretty well, but the smallest negligence in applying it renders it apt to scale, and to be penetrated by the fluoric acid. Strong varnish, composed of equal quantities of drying oil and mastich, has been tried. But it is very difficult to apply it evenly, and it is very long in drying. When the varnish is very dry, and the surface very even, the figure intended to be engraved is to be traced. But, the colour of the glass does not shew the lines, as copper does.

Plate-glass, which has a white reflection, must be chosen, and the lines of the engravings made upon it are equal in depth, and have no irregularities. When the weather is clear and serene, a piece of plate-glass, varnished, traced, covered with the acid, and exposed to the sun, may be engraved in five or six hours; but, in winter, the glass is but slightly attacked in four days, and the operation would never be finished if the action of the acid were not assisted by a moderate and regulated heat, such as that of an oven, or a stove. To judge of the state of the engraving, a corner of the glass must be exposed, and examined. The glass is to be drained, then washed two or three times with clean water, to take away the superabundant acid, and afterwards dried. The varnish may be taken off with a coarse cloth, dipped in spirit of wine, and the glass may be cleaned with chalk finely powdered.

Engraving on glass is also effected by warming the glass, and covering it with bees' wax. The design is then to be drawn in the wax by a point. Bruised fluor spar is then to be put into a vessel, whose top embraces the design, mixed with sufficient sulphuric acid for a paste. A very moderate heat then raises fumes of fluoric acid gas, which bite into the glass where exposed by the design. Different-sized vessels and drawings require a little accommodation.

*Engraving on precious stones.* Signets of *lapis lazuli* and emerald have been found with Sanscrit inscriptions of extreme antiquity; and our collections abound with intaglio and cameo hieroglyphics, figures, &c. &c. wrought upon jasper, emerald, blood-stone, turquoise, &c. Gem engraving, among the arts of Greece, reached perfection.

In engraving on precious stones, either the diamond is used, or emery. The diamond, which is the hardest of all stones, is only cut by itself, or with its own matter. The first thing is to cement two rough diamonds to the ends of two sticks, large enough to hold them steady in the hand, and to rub or grind them against each other till they are brought to the desired form. The dust or powder that is rubbed off serves afterwards to polish them, which is performed with a kind of mill that turns a wheel of soft iron. The diamond is fixed in a brass dish, and thus applied to the wheel, which is covered with diamond-dust, mixed with olive-oil, and when the diamond is to be cut facet-wise, first one face is applied to the wheel, then another. Rubies, sapphires, and topazes, are cut and formed the same way on a copper wheel, and polished with tripoli diluted in water. Agates, amethysts, emeralds, hyacinths, granites, rubies, and others of the softer stones, are cut on a leaden wheel, moistened with emery and water, and polished with water on a pewter wheel. Lapis lazuli, opal, &c. are polished on a wooden wheel. To fashion and engrave vases of agate, crystal, lapis lazuli, or the like, a kind of lathe is made use of, like that used by pewterers, which holds the tools, turned by a wheel, and the vessel is held to them to be cut and engraved, either in relievo or otherwise; the tools being moistened from time to time with diamond-dust and oil, or at least emery and water. To engrave figures or devices on any of these stones, when polished, such as medals, seals, &c. a little iron wheel is used, the ends of whose axis are received within two pieces of iron, placed upright, as in the turner's lathe, and to be brought closer or set further apart at pleasure; at one end of the axis are fitted the proper tools, being kept tight by a screw. Lastly, the wheel is turned by the foot, and the stone applied by the hand to the tool, and is shifted and conducted as occasion requires.

*To engrave dies*, or punches, matrices, and dies, for striking coins, medals, and counters. The engraver usually begins with steel punches, which are in relievo, and serve for making the creux, or cavities of the matrices, and dies. The first thing is to design his figures; then he moulds them in white wax, of the size and depth required; and from this wax he cuts his punch, which is a piece of steel, or, at least, of iron and steel mixed; on which, before they temper, or harden it, the intended figure, whether a head, or a reverse, is cut, or carved, in relievo. The instruments used in this graving in relievo, which are much the same as those wherewith the finishing the work in creux is effected, are of steel: the principal are, gravers of divers kinds, chissels, flatters, &c.; when the punch is finished, they give it a very high temper, that it may the better bear the blows of the hammer. The *matrice*, or *matrix*, is a piece of good steel, of a cubic form, called also the *dye*, whereon the relievo of the punch is struck in creux. To soften this steel, that it may more easily take the impressions of the punch, they make it red-hot; and, after striking the punch thereon in this state, they proceed to touch up, or finish, the strokes and lines, where, because of their fineness, or the too great relievo, they are in any respect defective.

The figure thus finished, they proceed to engrave the rest of the medal; as the mouldings of the border, the engrailed ring, letters, &c. all which, particularly the letters, and graining, or engrailment, are performed with little steel punches, well tempered and very sharp. And, that as they sometimes make use of puncheons to engrave the creux of the matrix, so, on some occasions, they make use of the creux of the matrix to engrave the relievo of the punch. When the matrix is quite finished, they temper it, rub it well with a pumice-stone, and clean out the stone again with a hair-brush; and, lastly, polish it with oil and emery: in this condition it is fit for the mill, to be used to strike coins, medals, &c.—*Partington.*

*To engrave on stone, or in lithography.* The effects are produced by a tracing made on the stone with a fat or resinous body. Since a line, drawn with a pencil or fat ink on a stone, adheres to it so strongly that mechanical means must be employed to remove it; and all those parts of the stone which are not covered with fat or grease receive, retain, and absorb water, while, if over a stone so prepared, a layer of greasy and coloured matter be passed, it will attach only to the lines made by the greasy ink, while it will be repelled by the wetted parts.

The lithographic process depends, therefore, on the circumstance, that the stone which has imbibed water repels ink, and that the same stone, when greased, repels water and holds ink. Thus, by applying and pressing a sheet of paper on the stone, the greasy, resinous, and coloured lines alone will be transferred to the paper, giving the impress of what they represented on the stone, and by making a drawing on paper with prepared ink, and transferring it to the stone, impressions exactly like the original may be obtained, that is, not reversed, as is the case in engravings on copper. All stone which is susceptible of being penetrated by a fat substance, and of imbibing water with facility, are proper for lithography, provided they are compact, take a good polish, and are of a light and uniform colour.

When the stone is prepared and polished, the artist may, without any other preparation, sketch his design as he pleases, and finish it with the crayon, the pen, or the pencil. The grain of the stone being uniform, and finer than the finest wove paper, he may execute his work in the most delicate manner: but a lithographic stone absorbs any grease applied to its surface, and consequently any grease or dirt so applied by chance or neglect, comes forth in the printing, as well as that grease which constitutes the drawing, even the finger-marks and rest of the hand.

Ink drawings are generally made on polished stones, as the grain necessary for a chalk drawing makes it unpleasant to draw with the hair-pencil or the pen. It is of the greatest importance that the grain of a stone for a chalk drawing be not too fine, and a little practice will soon shew the artist which is the proper grain; if too coarse, the drawing, particularly the delicate tints, will look open and sandy, and the execution will be attended with great trouble, especially in making out the minute parts. On the other hand, if the grain be too fine, the chalk slips, and draws greasy, the stone does not appear to bite, and there is difficulty in producing dark tints. Moreover, in the printing, the darker parts soon clog up, and from the stone approaching to the polished state, the delicate tints do not hold, and soon break up.

Although it is impossible to draw with chalk on a polished stone, ink may be, if employed with judgment, applied with great advantage in chalk drawings. Portraits admit of, and even require, a coarser grain than landscape, particularly if drawn in the stippled manner. Success is more certain, and the impressions will possess a degree of brightness which can never be attained with a finer grain. By employing a sharp-pointed pencil for the more delicate tints, and occasionally opening and picking with a needle those small specks which occur in working on a coarse stone, a clever artist can produce drawings which bear being placed next to the best specimens of copper-plate engraving. It must, however, be borne in mind, that in every case, whether figures or landscape, a coarse-grained stone is by far a less evil than too fine a one, as a failure is often the consequence of too fine a grain; whereas, a little more trouble in the execution of the drawing, is the only risk which the artist runs in working on a coarse grain.

The press at first employed in the lithography was exceedingly complicated, but the apparatus has been materially simplified by Taylor and Martineau's improved press.—*Partington.*

*Engravers' stopping-out varnish.*—In spirit of turpentine, mix lamp-black to the consistence of thick tar. *(keep in a pot.)* Or, *(Callot's for etching.)* To soft varnish add half its weight of bees' wax. *(Soft)* Melt and reduce one-third, 4 oz. of linseed-oil, and half an oz. of white-wax and gum benjamin.

ENIMAS, or GLISSOIRES, made of caoutchouc, are now regarded as the best openers of the rectum, and remedies for habitual costiveness, and as more safe and efficient in procuring healthy eliminations than any cathartics. They are most convenient in use, and have superceded the metal syringes of French invention, both in France and England.

EPACT, is the moon's age for the first day of January, or the *equation* between the beginning of the solar and the lunar year. The time from one new moon to another is about 29½ days. Thus there are, in a year, twelve revolutions of the moon, and 11 days over: therefore, the twelfth new moon will take place 11 days earlier each year than it did the year before. In the lunar cycle of 19 years, there are 12 new moons in each of 12, and 13 in each of 7; because the 11 days of yearly difference in 3 years exceed a lunar month by 3½ days. If it were not for the odd minutes and seconds, the age of the moon on the 1st of January could always be found, by multiplying the golden number by 11, and dividing by 30, then the remainder would be the *epact*, or age of the moon, on the 1st of January. The following method will answer for the *day* of the moon's age on the 1st of January till the end of the present century: take 1 from the golden number, multiply what is left by 11, divide by 30; the remainder is the *epact*, or moon's age, on the 1st of Jan.

EPSOM SALT, or sulphuret of magnesia, is made by evaporating the waters of certain springs at Epsom, Shooter's Hill, &c. But it is more generally made from the bittern of sea-water or from magnesian lime-stone. The bittern yields it by simple concentration by heat, then dissolving again and re-concentrating. But if the bittern is applied to magnesian lime-stone, the muriatic acid of the bittern combines with lime, and the magnesia of the bittern and the magnesian lime-stone are precipitated.

ESSENTIAL OILS, are those volatile fluids usually obtained from aromatic plants, by subjecting them to distillation with water. The oil is volatilized with the aqueous vapour, and easily condensed a small portion of it is retained in solution by the water; but the greater part separates at the top, and is obtained pure from the difference in their specific gravity. In some instances, as, for example, in the rind of the orange and lemon, the oil exists in distinct vesicles, and may be obtained by pressure.

The principal volatile or essential oils are those of turpentine, aniseed, nutmeg, lavender, cloves, caraway, peppermint, spearmint, sassafras, camomile, and citron. The taste is acrid and burning; and the odour very pungent, resembling the taste and smell of the vegetables. They boil at a temperature considerably above that of boiling water; thus oil of turpentine boils at 315°. They are soluble in strong alcohol, but, on adding water, are precipitated. They are soluble in ether in like manner, but do not form soaps with alkalies, *by which they are distinguished from the fixed oils.* They are readily inflamed by strong nitric acid; especially if a little sulphuric acid be added, to render the acid more concentrated. Exposed to the action of the air, they undergo an alteration in consequence of the absorption of oxygen, become thickened, and gradually change into a solid matter, resembling resins. When digested with sulphur, they unite with it, forming *balsam of sulphur.*

One of the most useful is that of turpentine, called *spirit of turpentine.* It is obtained by distilling turpentine and water, in due proportions, in a copper alembic. It is the solvent employed in making a variety of varnishes, but it requires to be rectified by a second distillation.

In general, volatile oils are used in pharmacy or as perfumes. Those applied to the latter use, are the essence of roses, of jasmine, violets, &c. but require much care in preparation. This is best done by spreading upon white wool, impregnated with olive-oil, the petals of the flowers, and leaving them for some time, covered over with a woollen cloth, upon which flowers are also scattered. The flowers are renewed from time to time, until the olive-oil employed appears to be saturated with the oil of the flowers, and this last is then separated by digesting the wool in alcohol.

Essential oils are obtained by distilling the basis with an equal weight of water to prevent them from adhering to the still, and the oil and water acquiring a burnt taste; some, as those of the peels of fresh fruits, are obtained by rasping them, and pressing the raspings; a few by distilling the articles with twice their weight of water, adding 1 lb. of salt to each gallon of water, using a quick fire, and when half the water has come over, pouring it back again into the still, and thus cohobating it. When rectified, for the purpose of rendering them finer, they are distilled without water in a retort, and one half the oil is drawn over. They are all stimulant, in doses of 2 to 10 drops upon sugar, but are mostly made into cordial waters, by distilling with spirit of wine, or water. The following are some of the principal, for they consist of 2 or 300.

*Oil of Wormwood,*—25 lbs. of green wormwood yielding from 6 to 10 drs. of this oil.—*Oil of Acorns,*—50 lbs. yield 2 oz.—*Essential oil of bitter Almonds,* —from ground almond cake, by distillation, with twice as much water and half as much salt, after having been left to soak for some days, and when half the water is come over, pouring it back into the still: 25 lbs. of cake yield 2 oz. and contains prussic acid; when rectified, its strength is prodigiously increased.—*Oil of Anise-seeds,*—from the seeds; congeals at 62°.—*Oil of Star Anise-seeds,*—from the capsules, very fragrant.-*Oil of Dill-seed,*-Carminative. —*Essence of Bergamotte,*—from the peels of the Bergamotte orange; by pressure, very fragrant.—*Huile d'orange,*—from orange-peel, by pressure; very fragrant.—*Cajeput oil,*—from the leaves.—*Oil of Carui,*—from the seeds, carminative.—*Oil of Cloves,*—from cloves, soaked and distilled with salt-water, the distilled water being returned two or three times into the still; very heavy and acrimonious.—*Distilled oil of Camomile Flowers,*—from the flowers, stomachic.—*Oil of Cinnamon,*—from the fresh bark, distilled with sea-water.—*Rectified oil of Citrons,*—the pressed oil of the whole peels, distilled until 3 oz. out of 5 are come over, white, very fragrant.—*Oil of Cummin-seed.*—*Oil of Hops,*—Collected during the boiling of hops in beer.—*Essences des Violettes,*—from the root of Florentine orris; smells like violets.—*Essence of Jasmine,* from the flowers of J. grandiflorum, highly fragrant. *Oil of Lavender,*—from the flowers of narrow-leaved lavender, very fine scented.—*Oil of Spike*,—from the flowers and seeds of French lavander.—*Rectified oil of Lavender*,—Drawing off 3oz. in 5; used for choice perfumery.—*Riga Balsam*,—from the shoots of Pinus cembra, previously bruised and macerated for a month in water; vulnerary, diuretic.—*Essence of Lemons*,—from the fresh peels of lemons; limpid, watery, fragrant; used in perfumery.—*Oil of Mace*,—from that spice.—*Oil of sweet Marjoram*.—*Oil of Peppermint*,—from the dried plant, 4 lbs. of the fresh herb yielded 3 drs.; used to flavour spirit.—*Rectified oil of Peppermint*,—used for peppermint lozenges and drops, very warm.—*Oil of Milfoil*,—18 baskets yield 4 oz. 4 drs.—*Essence of Myrtle*,—from the flowers and leaves; fragrant.—*Essence of Jonquil*,—used in perfumery.—*Oil of Nutmeg*,—from that spice.—*Oil of Thyme*,—from the plant, 2 cwt. fresh yield 5½ oz. stimulant, makes the hair grow, used in tooth-ache.—*Oil of Pimento*,—from allspice.—*Oil of Penny-royal*,—from the herb when in flower.—*Oil of Raventsara*,—from the leaves; sold for oil of cloves.—*Oil of Rhodium*,—from Levant lignum rhodium: 80 lbs. yielded 9 drs.—*Oil of Roses*,—from the flowers of musk roses in the cups split open, soaked in twice their weight of salt-water for several days, then distilled, and the water cohobated once or twice on them: 1 cwt. yields from half an oz. to an oz. of oil.—*Attar of Roses*,—from the evergreen rose and the musk rose, the newly-distilled rose-water being exposed to the night air; a highly-esteemed perfume; freezes at 50°., melts at 85°.—*Oil of Rosemary*,—from the flowering tops; sweet scented.—*Rectified oil of Rosemary*,—by redistilling until one-half is come over, and used for fine perfumery.—*Oil of Rue*,—from the dried plant, carminative, antispasmodic.—*Oil of Savine*,—from the dried plant, stimulant and powerfully emmenagogue; externally rubefacient.—*Oil of Sandal-wood*,—1 lb. yields 2 drs. It is sold for oil of rhodium, and oil of roses.—*Oil of Sassafras*,—from the root of sassafras, with salt-water, and cohobation.—*Oil of Lemon Thyme*,—used to scent soaps.—*Oil of Tansey*,—from the herb.—*Oil of Thyme*,—2 cwt. fresh flowers yield 5½ oz.—*Oil of Turpentine*,—from rough turpentine distilled with an equal weight of water.

ESTAMINET, is a public room or shop where smoking is permitted, which is not allowed in coffee-houses, &c. In the Netherlands, public-houses in general are called *estaminets*, because smoking is permitted. *Estaminets*, with floods of beer and clouds of smoke, furnish a Dutchman's happiness. London, the same name has been given to shops where the nuisance of smoking is permitted.

ETCHING. In etching, the strokes and dots on the copper-plate, instead of being cut with a tool, are corroded by an acid, by which means the effect of engraving is produced with great expedition. To perform it the plate is covered with a thin coat of a resinous substance, upon which the acid employed has no action; the design, and all the lines it requires, are next traced with a steel point, so as just to cut through the resinous substance; an acid is then poured upon the plate, and allowed to remain on it till it has corroded the metal to a sufficient depth in all the places where the tracing has been made.—The resinous composition which is laid upon the plate is called the *ground*; and the instruments which are used to make the requisite lines upon it are called *etching-needles*. A dry-point may in fact be used as an etching needle, and *vice versa*, and the manner of whetting both is the same; but, etching needles are required of several thicknesses. They generally consist of pieces of steel wire, about two inches in length, inserted into cylindrical handles of hard wood, about five inches long, and the third of an inch in diameter. The steel tapers gradually towards the point, except a small portion of the extremity, which is made conical. They are whetted in a small groove, made at one end of the oil-stone.

There are three kinds of grounds in use, the hard, the common, and the soft, and for each kind the following recipes, says Mr. Partington, may be considered as the best.

For a *soft ground*, take 1 oz. of white or bleached bees' wax, 1 oz. of asphaltum, ½ oz. of common pitch, and ½ oz. of Burgundy pitch. Melt the wax over a slow fire, in a pot of glazed earthenware; and add, by degrees, the rest of the ingredients.

For a *common ground*, 3 parts of asphaltum, 2 of Burgundy pitch, and 1½ of white wax.

For a *hard ground*, take 4 oz. of fat oil, very clear, and made of good linseed-oil, like that used by painters. Heat, in a clean earthen pipkin, add to it 4 oz. of powdered gum mastic, and stir the mixture briskly, till the whole be well combined. Then press through fine linen into water, and form it into balls. This is called the Florence varnish.

To cover the plate with the ground it must be heated, in a common kitchen oven, or by holding it over a chafing-dish of charcoal. When it is hot enough, a ball of the ground to be used should be tied up in a piece of tiffany, and be dabbed over the heated plate, till a sufficient quantity of it is melted, to form a thin coat. The next operation is to blacken the varnish, which is done by holding the surface covered with it over the flame of one or more candles, according to the size of the plate, and moving it about till every part has been evenly blackened by the smoke.

To transfer the design to the ground, it must be traced upon transparent paper, with Indian ink mixed with ox-gall; another piece must then be coloured with red chalk, and the chalked side placed upon the ground on the plate, and the traced side of the transparent paper placed next above it, both being secured by wax at the corners. The design on the transparent paper must then be passed over with a blunted point, and on lifting up the papers, a distinct outline will be found, upon the ground, of the red chalk.

The etching needle must now be used, and the outlines and shades on the ground must be traced on the copper, through the ground, according to the design.

If false strokes are made, or if the ground be disturbed, a stopping mixture formed of turpentine-varnish and lamp-black must be applied.

Before the biting acid is poured on, the plate is to be surrounded with a ridge of bees' wax, softened by Burgundy pitch or tallow. The biting liquor is nitric acid diluted with equal water, and it is to be poured upon the plate, half an inch deep. It acts on the copper, wherever the strokes of the needle have penetrated, and bubbles will immediately rise to the surface. In half an hour, an hour, or more, the nitric acid is let off by a spout in the bees'-wax ridge. The plate is then washed, and the light parts when dry are filled with the lamp-black mixture. The ridge is repaired and the acid poured on again, and if necessary again, till the shades are complete. The plate is then washed, heated, and cleaned with olive-oil and a linen rag. Oil of turpentine clears all the lines.

No precise direction can be given for the length of time which the acid must remain upon the plate, and the real depth of the biting cannot be known, by examining a plate while the varnish is on it. From half an hour to an hour is the usual time for fine work, but a day and even several days is required for some designs.

Parts over-bitten are corrected wth the burnisher, or rubbed down with charcoal. If too faint, it may be rebitten in the part.

Machinery has been used to draw the lines upon the etching ground in mathematical and mechanical designs, consisting of lines and regular curves. The machine consists of a bar of brass or steel, upon which slides a socket, and to the socket is fitted a tube, which receives a steel wire, or hard point.—To adjust distances a very exact screw and an index is used to measure the exact breadth before any stroke is drawn. *Partington.*

*Etching Steel Plates.*—Biting on very soft steel plates may be accomplished by using the following mixture :—3 oz. of warm water, 4 grains of tartaric acid, 4 drops of nitric or sulphuric acid, 1 dr. of corrosive sublimate. The ground may be made to adhere to the surface of the steel, without using acid to dull the surface, by the following method :—Dissolve, by gentle heat (in a Florence flask,) some powdered copal in oil of spike lavender, and evaporate to a thick consistence ; then to 1 ball of ground add about 1 dr. of the copal solution, each having been made warm previous to mixing; lay the ground as before mentioned, avoiding too much heat ; the ground may then be laid with the same facility as on copper.

*Another.—Menstruum for Etching Soft Steel.*—Take a quarter of an ounce of corrosive sublimate powdered, and a quarter of an ounce of alum powdered, and dissolve them in half a pint of hot water. Let it cool before use. While using, keep stirring it with a camel's hair brush, and take care to wash the plate perfectly after each biting. As this acid, though clear before use, becomes turbid during its action on the steel, it may be prudent, in fine works, to throw away each portion of acid after it has been on the plate. Delicate tints are obtained in about three minutes.

*Etching on Glass.* Cover one side of a flat piece of glass, after having made it perfectly clean, with bees' wax, and trace figures upon it with a needle, taking care that every stroke cuts completely through the wax. Next, make a border of wax all round the glass, to prevent any liquor, when poured on, from running off. Then take some finely-powdered fluate of lime (fluor spar,) strew it even over the glass plate upon the waxed side, and then gently pour upon it, so as not to displace the powder, as much concentrated sulphuric acid, diluted with thrice its weight of water, as is sufficient to cover the powdered fluor spar. Let every thing remain in this state for 3 hours ; then remove the mixture, and clean the glass, by washing it with oil of turpentine ; the figures which were traced through the wax will be found engraven on the glass, while the parts which the wax covered will be uncorroded.

ETHER, is made by distilling equal parts of alcohol and sulphuric acid into a large cooled receiver. The product should be but half the alcohol. To purify it, shake it in a phial, with some water and slacked lime. It boils at 96°, and evaporates at low temperatures, its vapour being very inflammable. It consists of 5 hydrogen (5,) 4 carbon (24,) and 1 oxygen (8,) = 33. It is a powerful solvent, and its evaporation produces great cold, and counteracts burns and scalds, though a flame must not be taken near it. Alcohol, with muriatic acid, nitric acid, acetic acid, &c. form 12 different ethers of various properties, consisting of 1 atom of the acid and 1 of sulphuric ether.

ETHIOP'S MINERAL, is made by triturating 2 of sulphur with 1 of mercury till united. *Or*, mix equal weights by degrees of mercury to melted sulphur, and stir till combined.

EVAPORATION, is the conversion of liquids and solids into elastic fluids, by the atomic motion or propulsive action of heat, sufficient to overcome the elastic pressure of the air or other gas in which the fluid or solid is situated. Expose, for instance, water to heat; bubbles at first appear on the sides of the vessel, which, by degrees, ascend to the surface, and rise more rapidly in proportion to the heat. Water is evaporated by the heat of the sun, and even in the open air, and the vapor, rising into the air, is re-condensed into steam or clouds. The general cause of evaporation is the motion called heat; but different substances require different degrees of it. Water evaporates at a very low temperature, and, from the immense quantity which is spread over the earth, important changes in our atmosphere are occasioned by it. If we assume, as experiments justify, that the annual evaporation averages 30 inc. then, the surface of all the waters on our earth being assumed at 128,000,000 of geographical miles, 60,000 cubic miles of water would be annually changed into vapour; and the amount will be much greater, if we add the evaporation from moist earth and from the vegetable and animal kingdoms. In summer, evaporation is generally much greater than in winter; yet, it is not so inconsiderable in cold weather as we might suppose.

The past theories of evaporation are as absurd as the principles of caloric, repulsion, &c. with which they are mingled. A solid becomes a mobile fluid, by imparting motion to its atoms, and a fluid becomes gas as soon as the force or motion transfered to its atoms become greater than the force or motion of the elastic medium by which it is compressed and condensed.

*Artificial Evaporation* is a chemical process, usually performed by applying heat to any compound substance, in order to separate the volatile parts. It differs from distillation, its object being to preserve the fixed matter, while all the volatile substances are allowed to escape. Accordingly, the vessels in which these two operations are performed are different; evaporation being commonly made to take place in open, shallow vessels, and distillation in an apparatus nearly closed from the external air.

EVAPORATION IN VACUO. This has been lately practised by Barry, of Plough-court, with the best effect. It was found that the atmospheric elements combined with extracts, but by this method the active matter of the plant is obtained in purity. By thus evaporating watery or spirituous solutions, he obtains the native juices in concentration, and in the practicable forms for medical use. His extract of cinchonæ is made by distilling in vacuo a tincture of bark, till the whole of the spirit has evaporated, and the resin being removed, when cool, the residuum is inspissated at a low temperature.

Evaporation, distillation, and sublimation, are mere varieties of the same principle of process.

EQUIVALENTS.—*See* Atomic Theory, &c.

EXPANSION, in solid bodies, is determined by the pyrometer, and that of fluids by the thermometer. The expansion of fluids varies considerably; but, in general, the denser the fluid the less the expansion; thus water expands more than mercury, and spirits of wine more than water, and, commonly, the greater the heat, the greater the expansion. Water furnishes us with the most remarkable exception. Its maximum of density corresponds with 42°·5 of Fahrenheit's thermometer; when cooled down below 42°·5, it undergoes an expansion for every degree of temperature which it loses; and at 32°, the expansion amounts to $\frac{1}{160}$ of the whole expansion which water undergoes when heated from 42°·5 to 212°. With this, more recent experiments coincide very nearly; for, by cooling 100,000 parts in bulk of water from 42°·5 to 32°, they were converted to 100,031 parts. The expansion of water is the same for any number of degrees above or below the maximum of density. Thus, if we heat water 10° above 42°·5, it occupies precisely the same bulk as it does when cooled down to 10° below 42°·5. Therefore, the density of water at 32° and at 53 is precisely the same. Dalton cooled water to the temperature of 5° without freezing, or 37°·5 below the maximum point of density; and, during the whole of that range, its bulk precisely corresponded with the bulk of water the same number of degrees above 42°·5. The prodigious force with which water expands in the act of freezing, is shown by glass bottles filled with water, which are commonly broken in pieces when the water freezes. A brass globe, whose cavity is an inch in diameter, may be burst by filling it with water and freezing it; and the force necessary for this effect is 27,720 lbs. weight. The expansive force of freezing water may be explained by supposing it the consequence of a tendency which water, in consolidating, is observed to have to arrange its particles in one determinate manner, so as to form prismatic crystals, crossing each other at angles of 60° and 120°.

Every degree of Fahrenheit expands mercury the 9600th, water the 6666th, and air the 435th. Hence the *sp. gr.* vary at different temperatures and barometer. Thus, at bar. 29·27 and ther. 53°, air 1, water 836, mercury 11365, or 29·5 and ther. 55°—air 1, water 826, and mercury 11227; or water as 1000, air 1·201, and mercury 13592; *i. e.* 30 inches of mercury equal to 5·268 miles of air, or nearly 34 feet of water.

Water, from 60° to 100° expands 147th, Mercury the 243d. A cubic inch of brandy is 4 drs. 42 grs. at 25°, and only 4 drs. 32 grs. at 65°. In all spirits, 32 in winter is equal to 33 in hot summer by mere expansion. Spirits should, therefore, be purchased in cold weather.

Mr. Daniell has published the following Table of the progressive linear dilatation by heat of certain solids by his register pyrometer to the boiling point of water, the boiling point of mercury, and also their respective melting points, where they have been ascertained. He has added to their apparent expansions the corresponding expansion of black-lead; upon the assumption that the latter continues at an equal rate at temperatures above 662°.

*Linear Expansions of Solids by Heat, in the Dimensions which a bar takes whose length at* 62° *is* 1·000000.

| | At 212°. | At 662°. | At Point of Fusion. |
|---|---|---|---|
| Black-lead ware.. | 1·000244 | 1·000703 | |
| Wedgwood ware.. | 1·000735 | 1·002995 | |
| Platinum.......... | 1·000735 | 1·002995 | (1·009926 maximum, but not fused.) |
| Iron (wrought) ... | 1·000984 | 1·004483 | (1·018378 to the fusing point of cast-iron.) |
| Iron (cast)........ | 1·000893 | 1·003943 | 1·016389 |
| Gold ............. | 1·001025 | 1·004238 | |
| Copper ........... | 1·001430 | 1·006347 | 1·024376 |
| Silver............. | 1·001626 | 1·006886 | 1·020640 |
| Zinc .............. | 1·002480 | 1·008527 | 1·012621 |
| Lead ............. | 1·002323 | .... | 1·009072 |
| Tin ............... | 1·001472 | .... | 1·003798 |
| Brass. Zinc $\frac{1}{4}$ .... | 1·001787 | 1·007207 | 1·021841 |
| Bronze. Tin $\frac{1}{4}$ ... | 1·001541 | 1·007053 | 1·016336 |
| Pewter. Tin $\frac{1}{5}$ ... | 1·001696 | .... | 1·003776 |
| Type metal ....... | 1·001696 | .... | 1.004830 |

As long as the metal retains the solid form, the dilatation proceeds according to a fixed law, without any sudden starts or changes; but, on assuming the form of a liquid, it doubtless is subject to a different mode of action.

EXPANSION OF VAPOUR.—Since all gas and vapour are created by the projectile force of heat, or atomic motion, overcoming the elastic force of pressure, the reaction of the pressure converts their rectilinear projectiles into circular orbits, and these being enlarged by more heat, expansion is as heat directly, and as elastic pressure inversely. Experiments on the elastic force of vapour, in contact with water at high temperatures, are attended with difficulty, considerable expense, and some danger. Hence few experiments have been made on steam beyond the temperature of 343° of Fahrenheit under a column of mercury. Even at this temperature, steam supports a column of mercury 20 feet in height. The great difficulty attending experiments above this height, which is equal to eight atmospheres, renders it particularly desirable that some correct method be given for the calculation of force by temperature, founded on accurate experiments made below it.

With this view, Mr. Tredgold examined various experimental results on the elasticity of vapour, and compared the column of mercury supported with the temperature required to maintain vapour of sufficient tension to support the column; and the result of this comparison is, *that one-fifth, added to any given portion of heat, or atomic motion, already communicated to water, as indicated by the thermometer from the freezing-point, will double the elastic force of its vapour.* This law is easily reducible to a geometrical ratio for each factor. The ratio of force being 2, we have only to reduce 14 to the decimal 1·2 for the ratio of temperature. Having found the ratio, it is easy to calculate the force of vapour at any given temperature, and *vice versa*. For, by counting the number of terms in each series produced by the continual multiplication of both factors by their respective ratios, the corresponding temperature and force is seen at once. For example—

| | 1st. | | 2d. | | 3d. | | 4th. |
|---|---|---|---|---|---|---|---|
| Temp. | 180 × 1·2 | = | 216 × 1·2 | = | 259·2 × 1·2 | = | 311·04 |
| Force | 30 × 2 | = | 60 × 2 | = | 120 × 2 | = | 240 |

And, by adding 32 to either of the terms in the series of temperature, we have the degree of Fahrenheit. For instance, at the fourth term, we have for temperature 311°·04, force 240.—311°·04 + 32° = 343°·04, so that the force of vapour by calculation at 343°·04 of Fah. supports 240 inches of mercury, and at 343°·6 of Fah. it supports 240 inches by experiment. One practical advantage to be derived from the calculation of force by temperature is the application of a thermometer, as a check on the safety-valves of steam-engines.

EXPECTORANTS, are medicines which promote the expulsion of fluid from the lungs. The mechanical remedies are blisters, bleeding, and emetics. The stimulants are garlic, squill, and fœtid gums. The sympathetics are lozenges and vapours. To which are added, sulphate of zinc, bitters, digitalis, tobacco, tartarized antimony, &c. &c.

Expectorants are medicines, which, by experience, are found to increase the discharge of mucus from the trachea and cells and passages of the lungs. They are garlic and squills, also balsams and gums in lozenges. The lungs are, however, inaccessible, except by gases, or by rest, or by affections of the general system.

EXPLOSION, is the instantaneous gassification of a solid by intense heat, applied to its atoms previously fixed. It is chiefly displayed in gunpowder, which expands to 472 times the bulk of the powder, with a velocity of 10,000 feet in a second, and a force equal to 1000 atmospheres or 15,000 lbs. A cannon-ball is, in consequence, projected with the velocity of 1800 or 2000 feet per second.

It is seldom that the expansion of any elastic fluid bursts a solid substance, without throwing the fragments of it to a considerable distance. The reasons of this may be comprised in these particulars: 1. The immense velocity with which the aërial fluids expand, when affected by a considerable degree of heat. 2. Their celerity in acquiring heat, and being affected by it, which is much superior to that of solid substances. Thus air, heated as much as iron when brought to a white heat, is expanded to four times its bulk; but the metal itself will not be expanded the 500th part of that space. In the case of gunpowder, the velocity with which the flame moves is calculated, by Robins, to be no less than 7000 feet in a second, or little less than 70 miles per minute. Hence the impulse of the fluid is inconceivably great, and the obstacles on which it strikes are carried off with vast velocity, though much less than that just mentioned; for a cannon-ball, with the greatest charge of powder, does not move at a greater rate than 2400 feet per second, or little more than 27 miles per minute. The velocity of the ball again is promoted by the sudden propagation of the heat through the whole body of the air, as soon as it is extricated from the materials of which the gunpowder is made, so that it is enabled to strike all at once, and thus greatly to augment the movements of the ball. We may conclude, that the force of an explosion depends, 1. on the quantity of elastic fluid to be expended; 2. on the velocity it acquires, by a certain degree of heat; and, 3, on the celerity with which the degree of heat affects the whole of the expansile fluid.

Equal volumes of hydrogen and chlorine explode in the light of the sun.

EXTRACT, is the product of an aqueous decoction, and includes all those preparations from vegetables which are separated by the agency of various liquids, and afterwards obtained from such solutions, in a solid state, by evaporation of the menstruum. Some chemists, however, have affixed this name to one peculiar modification of vegetable matter, which has been called *extractive*, or *extract*, or *extractive principle*; which has a strong taste, differing in different plants: it is soluble in water, and its solution speedily runs into a state of putrefaction, by which it is destroyed. Repeated evaporations and solutions render it at last insoluble, in consequence of its combination with oxygen from the atmosphere. It is soluble in alcohol, but insoluble in ether. It unites with alumine, and, if boiled with neutral salts thereof, precipitates them. It precipitates with strong acids, and with the oxides from solutions of most metallic salts, especially muriate of tin. It readily unites with alkalies, and forms compounds with them, which are soluble in water. In the preparation of all the extracts, the London Pharmacopœia requires that the water be evaporated as speedily as possible, in a broad, shallow dish, by means of a water-bath, until they have acquired a consistence proper for making pills; and, towards the end of the inspissation, that they should be constantly stirred with a wooden rod.

EXTRACTS, VEGETABLE.—As the juices of almost all plants are more or less injured in their medicinal qualities, by being boiled down and evaporated in the usual way, the evaporation at Apothecaries' Hall is entirely effected by steam, so that the heat employed is under complete control; and by Barry's patent, the process is performed in vacuo. Houlton's process is as follows: the plant, being bruised, is to be submitted to the action of a press, to squeeze out the juice, which is then to be strained through fine linen. The depurated juice is now poured to the depth of the eighth of an inch into an earthenware plate, or a glass dish, and is to be exposed to a constant current of air, by placing it on the inner sill of a window, and raising the sash about an inch. The constant current of air thus produced occasions the rapid evaporation of the watery parts, and there remains a soft extract, retaining the colour, odour, and medical properties of the plant, with less alteration than by any other method. If the sun shines, a blind should be hung before the window, as vegetable juices are speedily changed by the action of solar light. The consistence is optional, but those that are hard will keep better than those that are soft.

EXTRACTIVE.—A non-descript substance, or material principle, which, by analysis, is yielded by the juices of plants. It is brown and bitter, and soluble in water and alcohol.

EYE-SALVE.—Melt together 6 drs. each of calumine and tutty, 2 drs. each of camphor and of lead dross, 1 dr. each of myrrh, aloes, sulphate of zinc, and sarcocolla, 12 oz. of fresh butter, and 2 oz. of white wax.

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FALLING, or weight of bodies; an important phenomenon, which used to be ascribed to gravitation, a translation of the word weights; so that, according to this wordy philosophy, weight was owing to weight. But the author of this volume has long proved, that all central force in planets is a necessary result of the *simultaneous* orbit, or progressions, and the rotatory motions, and that the direction to the centre is the constant diagonal of those motions, and the increase in the diagonal the exact quantity fallen in a given time. The rotation is a deflection from the line of the orbit motion, and this being much greater, the body deflected by the rotation is carried by the greater motion obliquely to the common centre of both motions. This is obvious in the equatorial plane, but, in latitudes, the diagonal is compounded of the orbit motions as one force, and of the sine and co-sine as to the rotatory or deflective force; and the square of the sine and co-sine being equal to the square of the radius, every where alike, the fall in direction and quantity agrees with that at the equator. The orbit velocity in a second is 98,132 feet, the equatorial circle is 1525 feet nearly, or in the perpendicular 970·85 feet, that 101·1 to 1, and this inversely, as 6·28318 the circle to the radius 1, the resulting force in the radius is 16·08725 feet as the mean fall. *Or*, taking the two motions as 98132 to 1525, and inversely as 4, the square of the diameter to 1, we also get 16·08725. The squaring the forces, and extracting the root of their sum, gives an analogous result, but, for popular explanation, the preceding may suffice.

FALLOWING, the rest of land, once deemed indispensable, but laid aside since it is found that the rotation of crops secures perpetual fertility. It is doubted whether fallows are necessary, even on strong soils, though insisted on by high authorities; but bone, or gypsum, or lime manure, seems to render fallows unnecessary on any soil. Gardeners vary their crops and manure, but never leave fallows. Why should farmers?

Some strong lands require fallowing, whatever may be the rotation.—*Coven.*

FARMING.—Farms are divided into breeding or grazing farms, suckling farms, dairy farms, and arable farms. But most of them unite all the objects.

In cultivating crops, the four great operations are draining, ploughing, manuring, and rolling, with and without spikes.

Arable land, in affording human food, is to pasture as 3 to 1; and, hence the importance of the convertible system, wherever it is practicable. Sir John Sinclair thinks, that not more than a 25th or 30th of any farm should be kept in old pasture, and that merely for occasional use, and that mere pasture robs 2 of every 3 of their share of food. The richness of pastures was vulgarly ascribed to their age; but it now appears, that by seed, a richer may be obtained in two seasons, from the naked prepared soil.

The agriculture economists, disregarding the gregarious nature of man, descrys the agricultural village, and insists on the advantages of farm-houses scattered over the land.

60 yards of elevation are considered

equal to a degree of latitude in all climates.

The difference of heat between enclosures and large open fields, is from 5° to 8°.

A public road near a farm is worth 5*s.* per acre.

Implements of cast-iron, gates, and even carts, are now becoming general. They cost little more than wood, and last times the number of years.

Fields are thought of the best size from 10 to 20 acres, according to the size of the farm.

The capital of a grazing farmer ought to be equal to 5 or 10 rents, and of an arable farmer 8*l.* to 12*l.* per acre.

It appears, that an acre of clover, tares, rape, potatoes, turnips, or cabbages, furnishes 3 times as much food as in natural pasture, besides producing, in alternate years, a crop of grain.

In breaking up pasture for this purpose early in winter, it is usual to drain, pave, and burn, and to plough in a thin coat of lime, or marl, or chalk. Sometimes it is trenched by 2 ploughs following each other, and by deep furrows, with 1 plough, and 3 or 4 horses. The value of the conversion depends on its extirpating weeds, and bad grasses.

In *clayey soils*, the usual process is paring and burning, especially if the clay results from powder of flint or silex. The crops then ought to be rape, fed off by sheep, beans, wheat, beans, wheat, fallow, wheat sown with grass seeds. If not pared and burnt, the first crop should be oats or dibbled beans; a naked fallow, or turnip-crop, should precede the sowing of grass seeds, to restore the pasture.

The tillage land in Ireland is about 14 millions of acres. The bogs 3½, and the mountain wastes 2½. In Great Britain, Sir John Sinclair considers the cultivated or used as 51 millions, and the wastes at 22 millions; of which, the utterly useless is but 2 millions. Hence the cultivated in the United Kingdom is 65 millions, and the wastes 28; of which, only 4 or 5 are irreclaimable.

The rule of perfection in animal food is the approximation of the weight of the eatable parts to the living weight, commonly taken as two-thirds. A prime Devonshire ox, weighing 114 stone, of 14 lbs, affords 79 stone of eatable matter, and of fat 10, hide 6, entrails and blood 12, and other parts 7, in all, 35; or less than the third, which would be 38 stone. In sheep, the usual proportion is 160 to 103, or 8 eatable to 5 offal.

Two horses are sufficient on a farm of 50 acres, in a rotation of 6 to 10 in fallow, or on light soils in turnips; in a rotation of 10 in wheat or barley, with grass seeds; or in oats, after the grasses; in beans, on strong soils, or in wheat.

A dairy farm should not exceed 50 cows.

Potatoes produce from 22,400 to 29,120 lbs. of food. Wheat, after deducting 2½ for seed, yields 21½ bushels, or only 1290 lbs., or 20 lbs. to 1 lb. And taking meat at about 200 lbs., the produce of potatoes to meat, is at a mean 128 lbs. to 1 lb.; and in wheat in bread to meat, as 5 lbs. to 1 lb. A man, therefore, who eats 1 lb. of meat, eats the exact equivalent of 6 lbs. of wheat, and 128 lbs. of potatoes.

All kinds of grain should be cut as soon as the straw just below the ear gives out no moisture on twisting, for then the circulation to the ear is stopped. Little is then shed.—*Young's Calendar.*

In nutriment, 1 peck of oatmeal is considered equal to 2 of potatoes. The first weighs but 9 lbs., and the last 56 lbs.; 3 oz. of boiled fat beef, are equal to a lb. of lean.

Swedish turnips can be transplanted.

Fern may be eradicated, by cutting low, and putting salt in the hole.

To prevent the necessity of every farm having a threshing-machine, a man and boy, with 3 horses, move with a machine from farm to farm, at 20*s.* per day; and 2 loads, or 80 bushels, are thrashed clean per day, without damaging the straw.

Farming accounts consist of a general daily entry in a book, of receipts on one side, and payments on the other; and afterwards, when the farmer has time, he should digest them under the following heads:—

Annual payments to farm servants.

Weekly payments for labour, including work done by the piece or quantity, distinguishing the thrashing of wheat, barley, &c.

A separate head for labour in reaping, mowing, and hoeing.

A separate head for fencing, making hedges and ditches.

Tradesmen's bills: as blacksmiths, wheelwrights, &c.

Repairs of buildings, of all descriptions, belonging to farm.

Taxes, assessments, poors'-rate, rates of all kinds, tithes, rent.

Seed of all sorts bought for sowing.

Hay, corn, bought for consumption on farm.

Dead Stock bought.

Live Stock bought.

Payments for manure; such as ashes, lime, &c.

Extra expenses; such as allowances to carters for long carriage, turnpikes, beer, and a number of small outgoings, which constantly occur.

Wheat crop; number of acres reaped, how much winnowed, sold, consumed in family, sown, and how otherwise disposed of.

Barley, ditto.

Oats, ditto.

Beans, peas, tares, and hay sold; similar produce of pulse under one head, ditto.

Number of sheep on farm; sheep, lambs, and wool sold, consumed, or otherwise disposed of.

Pigs, ditto.

Other cattle, according to the nature of the farm, ditto.

Butter, cheese, milk, and calves, ditto.

Poultry, ditto.

Extra profits on small articles sold; for carriage, when hired, &c.

If any wood on the estate, a head must be added.

This method of keeping accounts is framed for the use of the common corn farms. Grazing farms, lands cultivated for special objects, or where the cultivation is not entirely carried on for the customary purposes, will require that some of the heads should be omitted, and occasionally additional heads must be supplied. When the farmer has practised this plan for three or four years, he will easily make such further divisions as he may find desirable; but the mode first tried must be simple, and very intelligible. He will find out, from thus dividing the heads of expense, the departments where the weight of the outgoings mainly press, and may curtail and economize in such as may admit of some saving.—*Arthur Young, in Farmer's Calendar.*

FARMS, the tenure of one family, for purposes of cultivation, subsistence, and the supply of the public markets.

The size of farms ought, of course, to bear some proportion to the number of families in a country, otherwise an undue proportion must subsist as mere farm-servants, or be driven into artificial employments in towns, with interests opposed to the farming interests. This contrariety of interests would, however, be the direct act of the owners of the soil, who have so sub-divided it into farms, and for which they alone ought to suffer.

There are, in the United Kingdom, 56 millions of acres in cultivation, and about 4 millions of families; and, as a third of them, or 1,333,333, may live by artificial employments, so two-thirds, or 2,666,666 properly appertain to the land. But, assuming that half those assigned to agriculture are labourers, we ought to have 1,333,333 farms, which, in 56 millions of acres, would be about 42 acres to each.

It has, however, not suited the recent interests of the proprietors to subdivide their farms in this manner, and instead of 1,333,333 farms, there are in the United Kingdom, at the very most, not above 300,000 farms, providing for as many families, while each of them appears to sustain about three families as labourers.

In fact, but one million of families are permitted, by the land proprietors, to live as farmers, and as servants on the land; and as these are competent to give employment to only half as many more, or to 500,000 as artisans, and in other ways; so the land, by the false policy of letting, is allowed to support but 1½ millions out of the 4 millions, and the other 2½ millions thrown on chances, are a new and distinct interest in society, who, subsisting by manufactures and foreign trade, have personal interests foreign to those of the land-proprietors, who, by their mode of subdividing the land, have shut out this 2½ millions from their natural means of subsisting, by means of the land.

This 2½ millions of families having, therefore, no tie to the land, of course, demand freedom to exchange their products for those of other nations, and for any other articles, as corn, and articles of subsistence; but the English land-owner represents, in reply to such demand, that cheapening of corn would disable him from getting such high rents from the speculating farmers, to whom he has let his land in large tracts, and would render it impracticable to maintain his style of living, and to pay his proportion of the taxes, the interest of mortgages, and the annuities with which estates are encumbered.

To which, the other and more numerous class rejoin, that their industry is their only estate; that this is lessened in value by their inability to exchange it with other nations for the necessaries of life; that they have no means of sacrificing their wants to high rents, and to aristocratic style of living, and no greater sympathy in regard to fixed charges on estates, than the landed interests had for the trading interests; when, in 1826, they raised the value of money, without regard to the obligations of traders, and ruined nearly all the trading interests in Great Britain.

Such are the vital questions which, in 1833, agitate the people, aristocracy, and government of Great Britain. 2½ millions demand such a free-trade, in the necessaries of life, as may enable them to live; and a few thousand land-proprietors, who have forced this new and distinct interest into existence, oppose the claim. Of course, the 250,000 farmers and their labourers are neutral parties; since, if they got less for their produce, they must have their rents proportionally lowered.

In fact, it appears, that, at a mean, 250,000 farms in 56 millions of acres, is 224 acres to each; but, as many farms are not above 20 or 30 acres, so it happens, very improvidently, that others are 1000, 1200, and even 1500 acres!

The direct impost in customs' duties are not above 1 million per annum on corn, but the consequent increase in the prices of corn on the 48 millions consumed, is variously estimated at 19, 25 or 30 millions, according to different data; while the exporters contend that it also circumscribes their exchanges to the amount of several other millions; the duty being in effect paid by them.

It is contended, that farming would improve less, if farms were lessened in size; but this is a speculation which ought not to be opposed to a positive injury, since experimental farms, and agricultural colleges, would advance the science of cultivation far more than interested speculators. Besides, it is urged, that the late wars and the public debt were acts of the land-owners, who repeatedly pledged their *last guinea* for its support; and yet, by raising their rents, and by the corn bill, they have contrived to evade all payment, and throw the whole on labour, and the consuming population. Are land and houses to pay the interest, or personal industry?

Great interests are at stake, and the commerce and manufactures of the country must yield to the land-owners, or these to the two millions and a half; the majority of whom are struggling in great privation, want, and misery. If the number of farms were only doubled, it might relieve the immediate pressure, but as that number of farm-houses have, in the spirit of avarice, been destroyed, to obtain high rents, within the last 40 years, it would now be humiliating and expensive to have to rebuild them.

In England and Wales, there are—

| | |
|---|---|
| 3,250,000<br>1,250,000<br>3,200,000<br>1,200,000<br>1,200,000 | Acres employed in wheat; barley and rye; oats, beans, and peas; clover, rye-grass, &c.; roots and cabbages by the plough. |
| 2,100,000 | Acres of Fallows. |
| 47,000 | Hop-grounds. |
| 18,000 | Pleasure-grounds. |
| 17,300,000 | Pastured by cattle. |
| 1,200,000 | Hedges, copses, and woods. |
| 1,300,000 | Ways and water-courses. |
| 5,029,000 | Waste lands. |
| 37,094,000 | Acres.—Total. |

*The Consumption of Wheat and other Grain in the United Kingdom.*

| | Wheat, Quarters. | Other Grain, Quarters. |
|---|---|---|
| A year...... | 12,000,000 | 40,000,000 |
| One month .. | 1,000,000 | 3,333,333 |
| One week ... | 250,000 | 833,333 |
| One day .... | 35,714 | 119,048 |

FAN-PALM; the talipot-tree, or great fan-palm *(corypha umbraculifera,)* is a native of Ceylon, Malabar, and the East Indies. It attains the height of sixty or seventy feet, with a straight cylindrical trunk, crowned at the summit by a tuft of enormous leaves, and is one of the most magnificent of the whole tribe of palms. These leaves are usually 18 feet long, exclusive of the leaf-stalk, and 14 broad; a single one being sufficient to protect 15 or 20 men from the rain. The inhabitants make use of the leaves for umbrellas, tents, or for covering their houses; and the Malabar books are formed of the same material, on which lasting characters are traced by means of a sharp-pointed iron style, which penetrates the superior epidermis. The pith, after being pounded, is made into a kind of bread.

FAT OF ANIMALS, differs from vegetable oils in fluidity at common temperatures. Of animal oils, whale-oil and sperm-oil are most generally known; and among the principal varieties of fat are spermaceti, butter, tallow, lard, and suet. Animal fat is a kind of solid oil, or oil and carbon.

The fat of animals, or more solid animal oils, may be separated from the membranous and other substances with which it is united, by melting it at a gentle heat, with the addition of a small quantity of water. Fat thus prepared is called *lard*, when of a soft consistence, and *tallow* when harder. It is insipid, and sometimes free from smell; at others, it has a distinct and peculiar odour. It is apt to become rancid, however, by keeping—a change connected with the absorption of oxygen. It is insoluble in water or in alcohol. It melts at 90° or 100° Fah.: by raising the heat, it is rendered more acrid, and exhales a pungent vapour. In close vessels, it is decomposed, and, among other products, yields a large quantity of olefiant gas. It is inflammable, and affords, by combustion, water and carbonic acid. The acids act chemically on fat. Sulphuric acid chars it. Nitric acid, mixed with it in small quantity, gives it a firmer consistence, and renders it soluble in alcohol. In this state it has been called *oxygenated* fat. The animal oils and fats combine with the alkalies, and form, with these, perfect soaps. With some of the earths, and metallic oxides, also, they form saponaceous compounds. They even facilitate the oxidation of some of the metals, as copper and mercury, by the atmospheric air.

Animal fat is not homogeneous, but consists of two different proximate principles, called *stearine* and *elain*, the former of a firm consistence, resembling suet or tallow; the other more soft or liquid, and analogous to vegetable oils.

FEATHERS, the peculiar covering of birds, consist of the tube, the shaft, and the barbs. The tube is a hollow, transparent, horny cylinder, constituting the root of the feather; the shaft is elastic, and contains a white, dry, and very light pith. The tube contains a vascular substance, composed of numerous cells, joined together, and communicating with each other. This is enveloped by the tube, but communicates with the skin by a small opening at the root of the tube, and is probably the organ by which the feather is nourished. Two sides of the shaft are covered with the barbs, running in a uniform direction; and each barb forms, of itself, a little shaft, which is covered, in a similar manner, with little barbs on each edge. On the wing-feathers, the barbs are broader on one side than on the other; but on the other feathers, they are equal on both sides. The barbs are provided with barbules, by which they are bound so firmly to each other, as to appear to adhere together, although they are, in fact, entirely separate. The feathers of birds are periodically changed. This is called *moulting*.

The best method of curing feathers is to lay them in a room exposed to the sun, and, when dried, to put them in bags, and beat them well with poles. Feathers, when chemically analyzed, seem to possess nearly the same properties as hair.

*Cleaning Feathers.*—Take for every gallon of clean water 1 lb. of quick-lime, mix them well together, and, when the undissolved lime is precipitated in fine powder, pour off the clear lime-water. Put the feathers to be cleaned in another tub, and add to them a quantity of the clear lime-water, sufficient to cover the feathers about three inches, when well immersed and stirred about. The feathers, when thoroughly moistened, will sink down, and should remain in the lime-water three or four days; after which the foul liquor should be separated from them by laying them in a sieve. The feathers should be afterwards well washed in clean water, and dried upon nets. The feathers must be from time to time shaken on the nets, and as they dry will fall through the meshes, and are to be collected for use.

FEELING; one of the five external senses, by which we obtain the ideas of solid, hard, soft, rough, hot, cold, wet, dry, and other tangible qualities. It is the most universal of all the senses, and perhaps the only sense, since the others may be resolved into it, by organs which concentrate action on the sense of feeling. We see and hear with small portions of our bodies, but we feel with all. Many animals have no sense but that of feeling.

FELDSPAR; a name under which has been comprehended a great variety of substances, hitherto believed to form a single species, but which the researches of modern mineralogists prove to constitute several distinct species. The general figure of the numerous crystals of feldspar is an oblique prism, with unequally-produced planes, whose number varies from four to ten. These prisms are terminated by summits, composed, ordinarily, of two large, culminating faces, and several smaller faces, which seem to obey no constant law of arrangement. The lustre of feldspar is vitreous, sometimes inclining to pearly, upon the perfect faces of cleavage; prevailing colour white, inclining to gray or red; sometimes gray, flesh-red, and, rarely, verdigris green; translucent, and sometimes transparent, and occasionally offers a bluish opalescence in certain directions; hardness below quartz, but not scratched by the knife; sp. gr. from 2·53 to 2·6.

It is not common to find feldspar in distinct crystals. Its more usual mode of occurrence is in broad, foliated masses, variously disseminated among other minerals. Rarely it occurs in granular concretions; and, occasionally, it is quite compact. Before the blow-pipe, upon charcoal, it becomes glassy, semitransparent, and white, but melts only with difficulty, on its edges, into a semitransparent vesicular glass. A crystallized specimen, analyzed by Vauquelin, gave silica 64, alumine 20, potash 14, and lime 2.

Feldspar is the most generally diffused, both as to its local and geological situation, of all minerals, with, perhaps, the exception of quartz. It is an essential constituent of *granite and gneiss*, and frequently occurs in micaceous and argillaceous slate. It is contained abundantly in almost all porphyries, in which it sometimes exists in large imbedded crystals. It abounds in primitive and secondary greenstone, the traps and trachytes, forms a large part of lavas, and has even been recognised as an ingredient in many meteoric stones. It is occasionally, though rarely, found in veins, or beds, in primitive limestone; and though, when occurring along with quartz and mica, in the primitive rocks, it is most generally disseminated, yet it frequently forms concretions separated from those ingredients, assuming the shape of more or less extended irregular beds. If these be decomposed, by the action of the air, beds of porcelain earth are formed.

Several varieties of feldspar are used in the arts and manufactures.

1. The transparent opalescent variety from Ceylon and St. Gothard (commonly called *adularia,)* is much esteemed in jewellery.

2. The verdigris-green variety, called the *amazon-stone*, which comes from near Ekaterinbourg, in Russia, and which has also been found in small quantity in Massachusetts, is likewise much esteemed by the lapidary.

3. A third variety of this species, employed in jewellery, is the avanturine feldspar, which comes from the island of Cedlovatoi, near Archangel, and which is of a honey-yellow colour, and everywhere penetrated by little golden spangles.

4. The pure varieties of feldspar are used in the composition of the paste of porcelain; also for the enamel with which it is covered; and the decomposed variety, or porcelain earth itself, is the most important material in that department of manufactures.

FELTING, is the process by which hats are made of fur and wool, and is similar to that of fulling. The fibres of these substances are rough in one direction only, as may be perceived by passing a hair through the fingers in opposite directions. This roughness allows the fibres to glide among each other, so that when the mass is agitated, the anterior extremities slide forward in advance of the body, or posterior half of the hair, and serve to entangle and contract the whole mass together. The materials commonly used for hat-making are the furs of animals and the wool of sheep. The furs of most animals are mixed with a longer kind of thin hair, which is obliged to be first pulled out, after which the fur is cut off with a knife. The materials to be felted are intimately mixed together by the operation of bowing, which depends on the vibrations of an elastic string; the rapid alternations of its motion being peculiarly well adapted to remove all irregular knots and adhesions among the fibres, and to dispose them in a very light and uniform arrangement. This texture, when pressed under cloths and leather, readily unites into a mass of some firmness. This mass is dipped into a liquor containing a little sulphuric acid; and, when intended to form a hat, it is first moulded into a large conical figure, and this is afterwards reduced in its dimensions by working it for several hours with the hands. It is then formed into a flat surface, with several concentric folds, which are still further compacted, in order to make the brim, and the circular part of the crown, and forced on a block, which serves as a mould for the cylindrical part. The nap, or outer portion of the fur, is raised with a fine wire brush, and the hat is subsequently dyed, and stiffened on the inside with glue.

FEMALE PILLS.—In syrup of roses dissolve ½ oz. of salt of wormwood, and mix with 1 oz. of rhubarb, of extract of gentian, and of proto-sulphate of iron, and 3 oz. of aloes and guaiacum.

*Or*, Mix 1 oz. of hepatic aloes, ½ oz. of myrrh, 2 drs. of saffron, ½ dr. of oil of caraway, with simple syrup.—*Or*, same, without the oil of caraway.

FENNEL SEEDS, are aromatic, hot, carminative. The roots are opening. The leaves diuretic.

FERMENTATION, is the spontaneous change which vegetable matter undergoes when exposed to ordinary atmospherical action, called temperature. So long as vegetable substances remain in connexion with the living plants by which they were produced, the tendency of their elements to form new combinations is controlled; but, as soon as the vital action is destroyed, they become subject to the unrestrained influence of the atmosphere.

Owing to the difference in the constitution of different vegetable compounds, however, they are not all equally prone to fermentation; nor is the nature of the change the same. Thus alcohol, oxalic, acetic, and benzoic acids, may be kept indefinitely without alteration; while others, as gluten, sugar, starch, and mucilaginous substances, are very liable to decomposition. In like manner, the spontaneous change sometimes terminates in the formation of sugar; at another time, in alcohol; at a third, in acetic acid; and, at a fourth, in total dissolution of the substance.

This has led to the division of the fermentative processes into four distinct kinds, viz. the *saccharine*, the *vinous*, the *acetous*, and the *putrefactive* fermentation.

The only substance known to undergo the saccharine fermentation is *starch*. When this substance is kept moist for a considerable length of time, a change gradually ensues, and a quantity of sugar, equal to about half the weight of the starch employed, is generated. Exposure to the atmosphere is not necessary to this change, though the quantity of sugar is increased by access of air.

The conditions requisite for establishing the *vinous fermentation* are, the presence of sugar, water, yeast, and a certain temperature, or aërial action.

To observe the changes which occur, we must dissolve five parts of sugar in about twenty of water, add a little yeast, and, introduce the mixture into a glass flask, furnished with a bent tube, the extremity of which opens under an inverted jar, full of water or mercury, and then apply a temperature of 60° or 70°. In a short time, we shall observe the syrup become muddy, and air-bubbles form round the ferment. These unite, and attach themselves to particles of the yeast, rise along with it to the surface, and form a stratum of froth.

The yeasty matter will then disengage itself from the air, fall to the bottom of the vessel, to acquire buoyancy a second time, and so on. The fermentation will continue for two or three days, when it will terminate, leaving the impurities to subside, and the liquor clear and transparent.

The changes which are found to have occurred are the disappearance of the sugar, and the formation of alcohol, which remains in the flask, and of carbonic acid, which is collected in the inverted jar. The yeast appears to have operated only by bringing on the fermentation. The atmospheric air, having been excluded by the nature of the apparatus, exercised no effect upon the result. The true theory is founded on the fact, that the sugar, which disappears, is almost precisely equal to the united weights of the alcohol and carbonic acid; and hence the former is supposed to be resolved, during the process, into the two latter.

Though a solution of pure sugar is not susceptible of the vinous fermentation, without being mixed with yeast, yet the saccharine juices of plants do not require the addition of that substance; or they contain a principle, which, like yeast, excites the fermentative process. Thus the juice of the grape, of the apple, &c. ferments spontaneously, *but not without access to the air*; from which it would appear, that it must contain a principle which is convertible into yeast, or, at least, into a compound, which acquires the characteristic property of that substance, by absorbing oxygen.

When any liquid has undergone the vinous fermentation, or even pure alcohol, diluted with water, is mixed with yeast, and exposed in a warm place to the open air, the *acetous* fermentation takes place. This change is attended with an intestine movement, and the developement of heat and carbonic acid gas; the fluid, at the same time, becoming turbid, from the deposition of a peculiar filamentous matter. This process goes on tardily below 60°; at 50°, is very sluggish; and, at 32°, is wholly arrested. On the contrary, when the temperature is as high as 80°, it proceeds with vigour.

It is necessary to distinguish between the mere formation of acetic acid, and the acetous fermentation. Most vegetable substances yield acetic acid, when they undergo spontaneous decomposition; and inferior kinds of ale and beer are known to acquire acidity in a short time, even when confined in well corked bottles. These processes, and a variety of others, however, are quite different from the proper acetous fermentation, above described, being unattended with visible movement in the liquid with the absorption of oxygen from the air, or the evolution of carbonic acid.

The *true* acetous fermentation consists in the conversion of alcohol into acetic acid, the quantity of the latter being precisely proportional to that of the former. It has been imagined that pure alcohol contains a greater proportional quantity of carbon and hydrogen than acetic acid; that the oxygen of the atmosphere, the presence of which is indispensable, abstracts so much of those elements, by giving rise to the formation of carbonic acid and water, as to leave the remaining carbon, hydrogen, and oxygen of the alcohol, in the precise ratio for forming acetic acid. The acetous fermentation is conducted on a large scale, for yielding the common vinegar of commerce. In France, it is prepared by exposing weak wines to the air during warm weather. In England, it is made from a solution of brown sugar or molasses, or an infusion of malt. The vinegar thus obtained, however, always contains a large quantity of mucilaginous and other vegetable matters, the presence of which renders it liable to several ulterior changes.

The *putrefactive fermentation* is confined to those vegetable substances in which the oxygen and hydrogen exist, in a proportion to form water; and in such, particularly, as contain nitrogen. Those proximate principles, in which carbon and hydrogen prevail, such as the oils, resins, and alcohol, do not undergo the putrefactive fermentation; nor do acids, which contain a considerable excess of oxygen, manifest a tendency to suffer this change. The conditions requisite for enabling the putrefactive process to commence, are moisture, air, and a certain temperature. The temperature most favourable is between 60° and 100°. The products of the process may be divided into the solid, liquid, and gaseous. The liquid are chiefly water, together with a little acetic acid and oil. The gaseous products are light, carburetted hydrogen, carbonic acid, and, when nitrogen is present, ammonia. Pure hydrogen, and, probably, nitrogen, are sometimes disengaged. The solid product is a dark, pulverulent substance, consisting of charcoal, combined with a little oxygen and hydrogen, which, when mixed with a proper quantity of earth, is called *vegetable mould*.

Essential to fermentation are: 1. sugar, or an equivalent convertible into it. 2. Water. 3. Heat, or increase of atomic activity. 4. Leaven, or yeast. 5. Air.

Without saccharine substance the fermentation is acetic, or vinegar; with it the fermentation is vinous, or spirituous. These are followed by decomposition or putrescence, called the ultimate, or putrefactive fermentation.

It is most rapid from 70° to 100°. No vinous or beer fermentation takes place below 55°; and above 100° the acetous precedes the vinous while the alcohol evaporates as formed. It is slower as the heat, or atomic activity, descends towards 55°, and quicker as it advances towards 100°. Again, heat should rise inversely as quantity; 100 gallons will do best at 94°; 450 gallons at 72°, and 2000 gallens at 63°. Small vessels part with heat more rapidly than great ones; and the time is inversely as the heat; 100 gallons at 63° would take 8 days instead of 2. Again, fermentation generates from 2° to 22° of heat, as quantity and strength, and the sinking of this internal heat to that of the surrounding atmosphere, is the signal for the termination of the fermentation. No operation should be attempted where the atmosphere is less than 50°, and, when less, doors and vents should be closed, and fires lighted. If the atmosphere is 80° or 90°, the liquid must be set to work at 70° or 80°, and smaller vessels be used in summer than in winter. By regulating the heats, fermentation may be conducted with success in every season.

When fermentation is arrested, bottles or casks of hot water must be immersed, or water added to raise the temperature.

When the fermentation is too rapid, it can be checked either by adding a strong solution of wort or syrup, or cooling with jets and ventilation, or by evaporation from the outside of the fermenting vessel.

Whatever diminishes the strength of the wort, or must, increases the fermentation; whatever increases the strength diminishes the fermentation.

Heat also increases it, and cold diminishes it.

No fermentation takes place in a vacuum, or in carbonic acid gas, and air is essential; but, it is not necessary to leave the fermenting liquor uncovered, since the air penetrates and has saturated all the materials. When the fermentation has commenced, air favours the acetous more than the vinous fermentation. Much mixture with air converts the ferment to vinegar; and while the fermentation lasts, the liquor is protected by a stratum of carbonic acid gas lying over it.

Leaven accelerates fermentation through the whole mass, but the gluten and extractive in all vegetables favour fermentation, though of the acetous kind.

Without sugar there can be no vinous fermentation and no spirits. Its decomposition is the object of all brewing and distilling.

Sugar is either used, or starch, or fecula containing it, which is converted into sugar, and then into alcohol by the process of fermentation. The alcohol produced ought to be half the weight of the sugar in the must or wort, the strength of which is determined by Beaumé's saccharometer, but the quantity varies as the alcohol is taken at 19° or higher.

Acetous fermentation produces vinegar, whose constituents are 50·224 carbon; 2·863 oxygen; and 46·911 water.

Sugar is 42·47; carbon 57·53; water (or 6·9 hyd. and 50·63 oxy.) *Or*, 57·7 alcohol, and 35·34 carbonic acid.

Alcohol is 52·16 carbon; 13·04 hydrogen; and 34·8 oxygen. 300 sugar in water, and 60 yeast at 59°, afford 171·5 of alcohol, at the high strength of 0·822, 90 per cent. or 36·7 of *Cartier* carbonic acid 94·6, residuum 52, and loss 41·9, = 360.

Spirits, in relation to water, per gallon, weigh as under:—

| | | Drachms. |
|---|---|---|
| Water is taken at | | 2165 |
| Underproof | 1 in 2 | 2068 |
| Ditto | 1 — 4 | 2037 |
| Ditto | 1 — 6 | 2007 |
| Ditto | 1 — 8 | 1996 |
| Ditto | 1 — 10 | 1691 |
| Ditto | 1 — 15 | 1986 |
| Ditto | 1 — 20 | 1981 |
| Proof | | 1971 |
| Over proof | 1 to 20 | 1961 |
| Ditto | 1 — 10 | 1956 |
| Ditto | 1 — 8 | 1951 |
| Ditto | 1 — 6 | 1940 |
| Ditto | 1 — 4 | 1935 |
| Ditto | 1 — 2 | 1879 |
| Alcohol | | 1782 |

There is condensation, or loss of bulk, when water is mixed with over proof spirit, at the rate of a pint in 5 gallons, a gallon in 24 gallons, and 4 gallons in 65 gallons. It is the bulk of the spirit that is reduced, and the mixture is accompanied by rise in temperature.

After, or just before, the vinous fermentation has ended, the product must be distilled on spirits, or put into casks for preservation from the air; for if it

Of course, 100 gallons at 1 to 10 over proof, requires 10 gallons of water to make it proof; and 100 gallons underproof 1 in 10, contains but 90 gallons of proof. Ignorance of strength, on the part of the public, is the basis of the fortunes of cheap advertisers and vendors.

remain exposed, the oxygen of the atmosphere is absorbed and the acetic fermentation commences. The agitation leads to a continuance of fermentation in the casks, but as soon as ended they should be closely bunged up, and if not the liquor turns to vinegar.

But, if allowed to proceed further it becomes putrid, volatile alkali evaporates, an earthy deposit takes place, and the liquid becomes water.

Such is the progress of fermentation, its means, and its successive products.

Must is the juice of grapes, apples, or other fruit, before it has begun to ferment. It is very laxative when drank in too large quantity. When evaporated to dryness, the residuum is black. This must, put in a vessel at from 55° to 62°, expels carbonic acid gas, and forms a scum or crust, which eventually falls to the bottom. The liquor then is wine, cyder, perry, &c. and is to be put in close casks, or bottled, for keeping and use.

FERNS *(filices ;)* a family of plants, included by Linnæus in his class *cryptogamia.* They are herbaceous, or shrubby. Between the tropics, several species form small trees, having something of the aspect of palms, and are considered one of the greatest ornaments of those regions.

Filices are sweetish, astringent, and pectoral. A ley of the ashes of most of the species has been used as a wash to promote the growth of the hair, from the alkali contained in them stimulating the skin; whence they have been called *capillary herbs.* They consist of *true maiden-hair*, a fine pectoral, slightly astringent, and the decoction is a powerful emetic. *Cape of Good Hope maiden-hair*, is used as an aromatic astringent. There are also *black maiden-hair*, or *oak fern ; common maiden-hair*, and *wall rue*, or *tent wort*, having all nearly the same qualities as the true maiden-hair.

Other filices are *spleen-wort, (milt waste)* astringent; *hart's tongue*, astringent, vulnerary, pectoral, and used in spitting of blood, fluxes, and swelling of the spleen; *rough spleen-wort.* Root aperient and diuretic.

Ferns, are *female fern (common brakes).* Root vermifuge; and, in time of scarcity, it has been manufactured into coarse bread;—*male fern*, the root slightly bitter, astringent, and a good vermifuge in doses of 1 dr. to 4 dr.; expelling the tænia, either by the assistance of a strong purge, or by repeating the powdered root for some time. It is also boiled in ale, to flavour it. *Small oak fern*, acrid, septic. *White oak fern*, used for maiden-hair. *Brittle cup fern, Ad. album, Cyathea fragile, P. fragile, Cycl. fragilis.* Used for maiden-hair.—*(See* FILICES.) *Flowering fern*, the young shoots, made into a conserve, are a specific for the rickets; and the root boiled in water makes a kind of starch, to stiffen linen. *Moon wort*, leaves astringent. *Adder's tongue*, used to form an ointment for wounds.

FEVER, the generic name of a serious disease, of which there are several species, and many varieties and degrees.

Since animal life arises from the fixation and action of oxygen at the lungs, and the correlative action of nitrogen at the skin, vitality being an intermediate result, so an arrestation, or any extensive disturbance of these primary and essential actions and reactions between the lungs and skin, generates the disorder called FEVER. The species arise from the nature and extent of the cause or causes, and the varieties from the state of the constitution of the patient, and the condition of the solids and fluids of the bodily structure.

In general, the disturbance arises from affections of the skin, which does not balance in its nitrogen the oxygen fixed at the lungs, or does not evaporate sufficiently to maintain the thermal temperature of the system.

In the former, the biliary, or nitrogenous secretions are disturbed; and in the other, there is an excess of heat and an undue and diseased excitement of the entire system. But, whenever from any cause the lungs fail to fix sufficient oxygen, or the skin to perform its functions, then another class of phenomena arises, called *disease;* while all are varied by the previous state of the blood and fluids, and by the healthy or morbid condition of the solids.

*Inflammatory fevers* palpably arise from diminished action of the skin with constantly increasing heat from the continued fixation of heat in the lungs. The disease is the undue excitement of the blood and system, so that cure consists in restoring the action of the skin, and then in abating the *accelerated* excitement.

In *Intermittents* we may imagine a species of oscillation of the causes, with accelerations of one as to the other.

*Typhus* is the same fever in systems which will not bear the accelerated excitement, so that the excitement produces decomposition of the solids, and putrid fermentation of the fluids.

*Nervous fever* is of the same character, and applies to the medullary system, weakened by some undue application of mind.

*Hectic fever*, which usually accompanies diseased lungs, indicates that neither lungs nor skin perform their healthy functions; and in the case of extensive ulceration we may assume that the motion is abstracted from the oxygen without the requisite chemical decomposition; hence the fetid odour of the breath in diseased lungs.

In these views of the animal economy, we are to regard the arterial circulation as connected with the heart, and oxygenous from respiration; the venous as connected with the gall-bladder, and biliary system, or nitrogenous resulting from the skin; and the action of the stomach, alimentary canal, and nerves, as results of both. This theory results from corrected views of the nature of electrical action, and it indicates the sources of that action and reaction which are essential to every organic product, and to every substantial change.

Admitted, it suggests rational practice in the means of cure, and it removes all past mystery from the nature and causes of this extensive class of diseases.

FEUDAL SYSTEM, a social state, in which, by an arbitrary assumption, some insolent conqueror claimed the property of all the land, aud then, to avoid the irksome duty of exacting rents, or assessments, turned over large districts to favourites, on condition of their supplying him with armed men and money, to maintain his state. Such was the system of the chiefs, who, at the head of barbarous hordes, overran the Roman empire, and established a system of vassalage, oppression, and misery, which bore down mankind for nine or ten centuries, and from which we are only gradually escaping. Its remnants still constitute half the grievances of the European world, and the removal of them will probably cause the effusion of other rivers of blood. Hitherto the system has rather worn itself out, than been overcome by the virtue of mankind. The feudal lords destroyed one another, and they became extinct from defect of male heirs; their titles to land, therefore, were sold to a more sordid race, and only the worst features of the system perpetuated. The feudal lords, so extensively endowed, took but a 15th or 20th of the produce, but purchasers of their titles sought a 10th, and 8th, and in the last 40 years have claimed a 5th, 4th, and often a 3d, leaving the cultivator in destitution, and with no remedy but to conspire to keep up the markets. Hence, lands which at the revolution let at 1*s.* 6*d.* or 2*s.* per acre, have latterly let for 2 or 3*l.*

FIBROUS MATERIALS, as constituents of *Wool*, consist of 5 carbon, 2·8 hydrogen, 29·4 oxygen and 12·8 nitrogen.

*Cotton* fibre consists of 42·85 carbon, 5·3 hydrogen, 51·85 oxygen.

*Flax* is 44·25 carbon, 5·25 hydrogen, and 50·5 oxygen.

*Silk* is 50·8 carbon, 3·4 hydrogen, 34 oxygen, and 11·8 nitrogen.

FIFTH, is a distance comprising four diatonic intervals, that is, three tones and a half. *A fifth sharp* is an interval consisting of eight semitones.

FIG-TREE, (*ficus carica*) in the countries surrounding the Mediterranean, forms a principal article of food. The stem is from 15 to 25 ft. high, with a trunk sometimes 2 ft. in diameter, giving out a great number of long, twisted, pliant branches. The fruit is much esteemed, being constantly brought upon the table, during 5 months of the year, in the south of Europe. The process of increasing and ripening the fruit is an art which requires much attention. It is rendered necessary by the two following facts, viz. that the cultivated fig bears, for the most part, female flowers only, while the male flowers are abundant upon the wild fig-tree; and, secondly, that the flower of the fig is upon the inside of the receptacle, which constitutes the fruit. It is hence found necessary to surround the plantations and gardens, containing figs, with branches and limbs, bearing male flowers from the wild fig-tree. And from these wild flowers, the fertilizing pollen is borne to the other figs upon the wings and legs of small insects, which inhabit the fruit of the wild fig.

Dried figs are of easier digestion and more nourishing than the fresh fruit, and form a considerable article of commerce. Dried figs, with barley bread, are now the ordinary food of the lower classes in Greece and the Archipelago. There are five principal methods of reproducing this valuable tree:—1. By seeds, which is but little employed. 2. The easiest mode is by suckers, which may be separated from the roots of the old trees. 3. In the month of March or April, branches are passed through pots containing earth, which is occasionally watered to keep it moist; roots are produced with facility, and the branches may be separated in the autumn. 4. A method which requires less trouble, and is most in use, is the following: in March or April, a bough about 2 ft. long and 2 years old is selected; the largest of its branches is reserved for the future stem, and the others are extended in the earth, and give out roots. Almost every variety bears fruit twice in the season.

The other species of *ficus* are shrubs or trees, with alternate leaves and branches, and having a milky and acrid juice. More than 100 species are known, the most remarkable of which are: *F. sycomorus*, a large tree, the fruit of which is eaten in Egypt and the Levant. The wood is incorruptible, and the cases of Egyptian mummies are made of it. *F. Indica* (Indian fig or banyan tree) has been celebrated from its letting its branches drop and take root in the earth, which, in their turn, become trunks, and give out other branches, a single tree thus forming a forest. *F. elastica*, the juice of which yields *caoutchouc*, or gum elastic, is a native of the mountains of Nepaul, and of the Maranon in South America.

Figs roasted or boiled, and split, are efficacious plasters for gum-boils, buboes, boils, &c.

FILBERTS, (*preserving of.*) When perfectly ripe, remove the husks, and dry the nuts by rubbing with a coarse cloth; sprinkle the bottom of a stone jar with a little salt; then place a layer of filberts, adding a small quantity of salt between each layer. The jar must be perfectly dry and clean. Secure the top from air, keep them in a dry place, and at the end of six months they will still peel.

FILLAGREE WORK, a kind of ornamental work in gold or silver, wrought delicately, in the manner of little threads or grains, or of both intermixed. In Sumatra, the workmen melt the gold in a crucible of their own forming, and, instead of bellows, they blow with their mouths through a piece of bamboo. They draw and flatten the wire in a manner similar to that adopted by Europeans. It is then twisted, and thus a flower, or the shape of a flower, is formed. A pattern of the flowers or foliage is prepared on paper, of the size of the gold plate, on which the fillagree is to be laid. According to this they begin to dispose on the plate the larger compartments of the foliage, for which they use plain flat wire, of a larger size, and fill them up with the leaves. A gelatinous substance is used to fix the work, and, after the leaves have been placed in order, and stuck on, bit by bit, a solder is prepared of gold filings and borax, moistened with water, which is strewed over the plate; and after being put into the fire a short time, the whole becomes united. When the fillagree is finished, it is cleansed with a solution of salt and alum in water.

FILTERING APPARATUS. Take an unglazed inverted vessel, manufactured at potteries for the use of sugar-bakers, and place it through a hole in a triangular board, resting upon two ledges. In the inside of the pot a bushel of the whitest well-washed sand is to be introduced, mixed with half-a-peck of finely-bruised charcoal. But before the sand is placed in the vessel, the small hole at the bottom of the pot should have placed over it a cup or saucer, with the convex side uppermost, to prevent the sand washing through. This filters foul water very quickly. When the sand becomes foul, it can be taken out and washed, or fresh materials repeated.

FILTRATION, is the process by which a liquid is freed from solid bodies mixed with it, by passing it through a linen or woollen bag, or filtering paper, &c. Coarse-grained porous stone is also used for filtering water. It suffers the liquid to pass through, but retains the impurities which it contains, and is called a *filtering-stone.* Other contrivances have been invented for purifying muddy, corrupt, and putrid water, and rendering it fit for drinking, as sand and charcoal; but, as impurities of the water adhere to them, they must be carefully washed from time to time. The largest filtering establishment is that in Paris, for the purpose of purifying the waters of the Seine, and there is another at the Chelsea Water-Works.

The pond at Chelsea which contains the filter-bed is 44 ft. square at top, and made with sloped banks, the bottom being 26 ft. square; it is 6 ft. deep; the mode of forming the bed was as follows:—After the pond was made water-tight, with a drain through the bank to the well, the bottom was covered with coarse gravel, in which drains were built without any cement between the joints of the bricks; they were covered with coarse gravel, and then with finer gravel, with coarse sand and finer sand, until the strata of gravel and sand were each 2 ft. thick, both gravel and sand having been selected with care, and well washed. The reservoirs were each 32 ft. square at top, 20 ft. at bottom, and 4 ft. deep; the low-water line of them being level with the high-water line of the filter bed; the reservoirs were worked alternately on the filter bed, and it was regulated to filter 12,000 cubic ft. of water every 24 hours; and the water was remarkably pure and limpid after it had passed the bed. The silt which was stopped on the bed was regularly cleaned off with a small portion of the sand every 14 days.

FIR, Scotch, or pine, next to the larch is a valuable tree for plantations, especially on poor sandy soil, or on moors if not too wet, and even on stiff clay. Four grow on the ground of one oak, and the branches serve as fuel and food for deer and sheep. The old Scotch or Baltic fir must be distinguished from the new or Canada. The silver fir produces still better timber. The spruce fir is a valuable nurse to young oaks, &c.

Scotch firs produce, from the decay of the leaves, an inch of vegetable soil in seven years. A succession of young ones make it a foot in half a century, fit for any cultivation.

FIRE, the first and most important

agent of human arts and civilization, is a result of motions imparted to one set of atoms to another set, and is a display of their intensity on the atoms which compose other bodies. Its common, if not its universal cause, is the excitement of atoms of hydrogen and carbon, and the *fixation* of the atoms of the oxygen in the space, whose previous motion being transferred by the combination, it constitutes the heat and flame of the phenomena.

The word *fire*, with different epithets, or *ignis* (Latin,) has been used for the spontaneous or casual combustion of gaseous substances. Such is the *ignis fatuus*, the jack-with-the-lantern, or will-with-the-wisp, observed in places where animal matter is in a state of putrefaction. Fire damp in mines is carburetted hydrogen gas, which, when mixed with a certain proportion of atmospheric air, and brought into contact with burning bodies, explodes.

The warm springs, the existence of extinct volcanoes, the effects of those still in activity, and the fact that the temperature of the earth becomes warmer the deeper we descend induced the idea of central fire.

Among the meteors accompanied by luminous appearances are *bodies* or *fire-balls*, moving with extreme rapidity and great brilliancy through the air; they are sometimes attended by a rumbling noise, like that of a loaded waggon; often followed by a violent explosion, accompanied with a fall of stones, more or less abundant, the origin of which is yet dubious. Small balls of this sort are called *shooting stars*, and there are various conjectures in regard to the nature of these phenomena.—Chladni considers them to be solid masses, formed above the region of our atmosphere, and classes them with aerolites or meteoric stones. The Editor considers them as masses of matter floating in space, and encountered by the earth's atmosphere in the annual orbit, the rapid motions of which accord with all the circumstances.

Fire always originates in motion. It is in every case the momentum of a mass transferred to atoms. The collision of flint and steel, the friction of wood, and various kinds of friction, also the blows of a hammer, generate the atomic motion called heat; and this, in connection with various atoms, produces flame or fire. We then contrive to support it by proper materials, and the oxygen of the air continuing to be fixed, a fire for sundry purposes is the result.

Burning is the effect, but burning ceases if evaporation disperses as much motion or heat as the oxygen imparts; hence water stops fire. Or, if the access of oxygen is intercepted, then the burning ceases, as by any covering.—*See* Combustion, Flame, &c.

FIRE-ENGINES, are forcing pumps, in which the water is subjected to pressure sufficiently strong to raise it to the required heighth. But, to produce the discharge of a continuous stream, a vessel filled with air is attached to the engine, and the water is forced into this vessel by two forcing pumps, and the air therein being condensed, it reacts on the water with a power proportioned to the condensation. Thus, if the air is condensed one-third, its elasticity will be three times greater than that of the atmosphere, and it will raise water in a tube to the height of 100 ft. The spouting pipe for directing the water upon the fire proceeds from the common air vessel. The handles are so disposed that while the piston of one pump is up, that of the other is down; and they are elongated for the purpose of enabling a great number of men to work them at the same time, so that they may throw a large quantity of water.

In *Newsham's* engines, two cylinders, constructed like forcing pumps, are worked by the reciprocating motions of transverse levers, to which the handles are attached. In this way the water is forced into the air vessel, from which it afterwards spouts through a moveable pipe. In some engines, a single cylinder is used, the piston rod passing through a tight collar, and alternately receiving and expelling the water at each end of the cylinder.

In *Rowntree's* engine, and some others, a part of the inside of a cylinder is traversed by a partition like a door hinged upon the axis of the cylinder, which drives the water successively from each side of the cylinder into the air vessel. The *hose*, a long flexible tube made of leather, is of great use in carrying the orifice near to the flames, and thus preventing the water from being scattered too soon. It also serves an important purpose in bringing water from distant reservoirs, by suction created in the pumps of the engine.

In *Braithwaite's* engine, is an ingenious application of the moving power of steam to the working of fire-engines. The mechanical arrangement consists of two cylinders, the one of 7 inc. diameter, being the steam cylinder, and the other of 6½ inches diameter, being the water-pump. By the horizontal position of the two cylinders the parallel motion is easily produced. This engine will deliver about 9,000 gallons an hour to an elevation of 90 ft., through an adjutage of ⅞ inch. The time of getting the machine into action, from the moment of igniting the fuel (the water being cold,) is 18 minutes. As soon as an alarm is given, the fire is kindled, and the bellows, attached to the engine, are worked by hand. By the time the horses are harnessed in, the fuel is thoroughly ignited, and the bellows are then worked by the motion of the wheels of the engine. By the time of arriving at the fire, preparing the hoses,&c. thesteam is ready.

A new steam fire-engine has been built by Mr. Braithwaite, for the King of Prussia. It is intended to be exclusively employed for the protection of the public buildings of Berlin.

The combustion is promoted by means of an exhauster, instead of a bellows ; the flue is in two lengths, and the greatest diameter 5 inc. The steam-cylinder is 12 inc. in diameter, with a 14 inc. stroke. The water cylinders are $10\frac{1}{4}$ inc. in diameter, with also a 14 inc. stroke. The steam from the eduction pipe is conveyed through two coils of tubing laid in the water tank, and imparts a considerable degree of heat to the water before it is transferred to the boiler. The feed pump is equal to the supply of from 20 to 25 cubic feet of water per hour.

The steam is got up (in 20 minutes,) and the pressure in the boiler is at 70 lbs. the square inch. The height to which the water is ejected is not less than from 115 to 120 feet. The number of strokes per minute is 18, which gives for the quantity of water thrown 1 ton 7 cwt. 13 lbs. per minute.

The water cylinder being $10\frac{1}{2}$ in diameter, the area of the water piston must be 86·6 square inches;

And a 14 inc. stroke of the engine gives for the length of the stroke in the water cylinder 56 inches ;

Therefore, $86{\cdot}6 \times 56 = 4849{\cdot}6$ cubic inches of water each stroke $= 2{\cdot}8$ cub. ft. Deduct for back-water through the valves 1 cub. ft. leaves for the effectual result 2·7 cub. ft.

And, multiplying 2·7 by 18, the number of strokes per minute, we have 48·6 cubic feet per minute = 3037 lbs. = 1 ton 7 cwt. 13 lbs.

Two pipes were afterwards substituted, of 7-8 inch in diameter ; then four of 5-8 inch in diameter ; and the effects produced in each instance was as nearly as possible equivalent to that obtained by the $1\frac{1}{4}$ inc. jet.

The average working power of the engine is between 80 and 90 tons of water per hour.

The consumption of coke is about three bushels.

For the supply of the great quantity of water necessary for the engine, cast-iron suction-pipes are to be laid under the pavement, with plugs to which the suction of the engine may be fixed. In consequence of this arrangement, the engine may be used as well for extinguishing fire itself as for supplying other engines with water. As there are 400 ft. of hose belonging to it, the water may even by that means be conveyed to great distances ; and a large plane may be protected by placing the engine into a circle, the radius of which is 400 feet. This powerful engine requires an engineer, a stoker, and 1 to 4 men to attend to the hose. It saves the strength of 42 to 105 men, according to its size from 6 to 15 horse power. It does not tire, works regularly, and requires no relief.

*Cooper's Rotatory Fire Engine* is on the *rotative principle*, worked by 16 men, with 11 inc. lever. It discharges through a 4 inc. pipe, more water than three 8 inc. cylinders, with 9 inc. strokes, and 15 inc. lever, worked by 34 men—and as much water as four $6\frac{1}{2}$ inc. cylinders, 9 inc. stroke, worked by 36 men with 24 inc. lever. This experiment was made at New York, in September, 1827. The same engine with 12 men, 11 inc. lever, threw more water than 2 engines, worked by 36 men, with 24 inc. lever.

A rotative engine, with 20 men, exerting an estimated power of 35 lbs. per man, with 7 inc. lever, has thrown from an inch pipe, 156 ft. horizontal, and 109 ft. in height.

A rotative engine, with 8 men, exerting an estimated power of 50 lbs. per man, has thrown from a half-inch pipe, 148 ft. horizontal, and 103 ft. in height.

The quantity of water discharged by the first engine was 525 gallons for each 130 revolutions. By the second, 304 gallons, each 100 revolutions. By the third, 128 gallons, each 100 revolutions.

In the first engine the revolving cylinder was 13 inc. long, and 8 inc. in diameter, and the surface acting upon the water was 40 square inches. In the 2d the revolving cylinder was 12 inc. long, $6\frac{1}{2}$ inc. in diameter, and it had a surface of 30 square inc. The 3d cylinder was 9 inc. long, 5 inc. in diameter, and 18 square inches acting surface.

It raised double the quantity of water, since in working the old engines, to discharge the chamber or cylinder once, the piston must pass twice through it ; an ascending stroke to create a vacuum, and a descending one to force the water. Half the time is consequently lost. In the rotative, a continued vacuum is created, and a continued discharge effected.

It works with one-half the power, since the air-vessel is totally dispensed with ; and the power is applied directly upon the water. It operates on no more than it discharges. On the other hand, as a consequence of the alternating motion of the piston engines, twice the surface is acted upon, and the friction, of course, is comparatively two-fold.

To extinguish fires, at their commencement the most ready means is a mop and a pail of water, applied directly above the flaming parts; when intense, the certain means is to apply water in the spots burning most, and following the flames, remembering that all flame ascends, and that ascent is only promoted by dry combustible materials over.

In cases of the clothes of females taking fire, the only remedy is to lie down, since flame travels very slowly in bodies placed horizontally. Two yards of muslin held perpendicularly will flame intensely a yard high, and be consumed in half a minute; but if laid horizontally, a flame will be 10 minutes spreading over the surface, and not rise an inch high.

In houses on fire, flame ascends from floor to floor by stair-cases, window-frames, wainscoating, doors and door-jambs, so that if floors were not connected by combustible materials, no house could be consumed.

FIRE-FLY, a small beetle, which emits a beautiful phosphoric light from the under surface of the terminal segments of the abdomen. In North America, during the summer months, these little insects abound, and are particularly active and luminous after slight showers of rain, studding the trees and grass. In Europe, the fire-fly is replaced by the glow-worm, a wingless female insect. The male is not luminous and is guided to his mate by the light which she emits from a receptacle of phosphoric matter similar to that with which the American species is provided.

FIRE-PLACE. It is advantageous to make the perpendicular height of the fuel as great as is consistent with safety. A stratum of coals or ignited wood will radiate more heat into the lower part of the room, if placed vertically, than if laid horizontally. The fuel should also be so divided as to be easy of ignition, and so placed as to give free access of the air to all its parts, as the smoke is then more likely to be burnt. *Franklin's stoves* were cast-iron fire-places. Underneath and behind the fire-place was an air chamber, into which the air was admitted from without the house, by an opening through the wall, and which is discharged into the apartment by lateral openings, after being heated by contact with the fire-place. The smoke, being carried off by a circuitous flue, which passes upward to the top of the fire-place, and then descends to the floor, also parts with much of its heat before it escapes by the main chimney.

The *Rumford fire-place* is a common fire-place, constructed with a narrow throat to the chimney, for the purpose of diminishing the current of air, an advanced back to throw the fire further forward, and oblique sides (at an angle of about 135° with the back,) which radiate the heat more completely into the room.

The *double fire-place* is formed by setting a soap-stone fire-place into the chimney, leaving an air chamber, behind and beneath it, which communicates with the external air, and opens into the apartment. This fire-place is so constructed as to unite the advantages of the Rumford fire-place with those of a Franklin stove. The air to be heated should be taken from without the house: for, if taken from an entry or cellar, the temperature of those places would be very much reduced. The air chamber should be from 4 to 7 inches in diameter, as more heat will be conducted from the stove, and a great quantity of air moderately heated is better than a small quantity made very hot, which is apt to render the air of the apartment disagreeable.

As all heat ascends, the lower the grate the greater its intensity in the apartment; but there must be a free access of air beneath, since the oxygen in it, and its fixation, is the source of all the heat of the burning materials.

FIRE-SHIPS, are vessels filled with combustibles, and fitted with grappling-irons, to hook its enemies' ships, and set them on fire. For this purpose, the ribs, hold, and sides of the vessel, after being well tarred, are lined with dried furze, dipped in pitch and lees of oil, and sprinkled with sulphur; a number of hatchways are then cut along the deck, and under each is placed a small barrel of gunpowder; so that, at the moment of conflagration, each throws off its respective hatch, and gives ample vent to the flames. A train, which passes through every part of the ship, and communicates with every barrel, running round the deck, and passing out at the steerage window, completes the preparation below; whilst, above, every rope and yard is well covered with tar, so as speedily to convey the flames to the sails; and at the extremity of each yard-arm is attached a wickered hook, which, being once entangled with the enemy's rigging, renders escape almost impossible. The train, to prevent accidents, is never laid till the moment of using it; when, all being placed in order, and the wind favorable, with every possible sail set, so as to increase the flames, she bears down upon the enemy's line, whilst the crew have no other defence than crouching behind the after-bulwarks. When close, all hands descend by the stern into a launch fitted out for the purpose, and, at the moment of contact, the train is fired by the captain, with a fuse like Hancock's, and, every hatch being thrown off, the flames burst forth, at the same instant, from stem to stern; and, ascending by the tarred ropes and sails, soon communicate with the rigging of the enemy's vessel.

FIRE-ESCAPES. The large silver Isis Medal of the Society of Arts has been voted to Mr. J. Braidwood, of Edinburgh, for a fire-escape, which consists—1st. Of a single chain 80 ft. long, 18 oz. to the yard.

2d. A chain ladder of the same length, having two strong claws, by which it may be hooked to the sill of a window, the sarking or rafters of a roof, or any other fastening, according to circumstances.

3d. A small pulley with a claw attached, and a cord reeved through it strong enough to bear the weight of the ladder.

4th. A strong steel cross-bow, with some coils of fine cord, each of which has a bullet of 3 oz. weight attached to it.

5th. A strong canvass bag, capable of containing at least one grown person.

These articles to form part of the equipment of engines, and always accompany them when called out on an alarm of fire.

The buckets attached to the fire-engines are 9 inc. in diameter, and from 13 to 14 inc. in depth. They are made of canvass nailed to a wooden bottom, with a ring round the mouth, and a handle of tinned iron. When filled with water, the leakage is very trifling, not amounting to more than 1 inc. in half an hour, and the price is only from 4*s.* to 5*s.*: whereas leathern buckets of equal size cost from 10*s.* to 12*s.* a piece. They are kept in the engine-house suspended, not on hooks, but on nails bent rectangularly like tenter-hooks, so that they may be taken down or dislodged by a pole with the least possible loss of time. Their flexibility is also a great assistance in carrying them to the place where they are wanted, as they may be packed into a hand-cart or wheel-barrow with very little loss of space.

Another fire-escape has been invented by Mr. J. Read, Regent Circus, Piccadilly, and consists merely of a rope, to the end of which is fastened a loop or cradle of strong broad straps of web, sufficient to contain 2 or 3 persons. An iron ring, having a perpendicular bar crossing it like the tongue of a buckle, is to be screwed into the lintel over the window within the chamber, the rope being coiled in a serpentine form around the bottom of the ring by passing it through the two divisions made by the bar or tongue. Or a strong hook with a security spring, which the inventor has prepared, may be fixed above the window, and this ring hung upon it at the moment of escape. The rope, which must be twice the length of the height of the window from the ground (which may be rendered incombustible by saturating it in an alkaline solution,) being properly passed through the ring, coiled up, and placed in a closet, or any other convenient situation in the room; upon an alarm of fire, or in time of danger, the ring can be hung upon the hook in an instant. To escape from a window, a person has only to throw the rope (which uncoils itself as it falls) into the street, slip the cradle under him, take hold of the rope outside the window, and sliding out, gradually let himself down, by allowing the rope to pass from one hand to the other.

Dr. Birkbeck, in a recent lecture on fire-escapes, delivered at the London Mechanics' Institution, noticed the difficulty which lies in the way of escape on occasion of fire, from the circumstance that the smoke renders the air completely suffocating, and the combustion deprives it of the power of supporting life; and individuals are therefore occasionally rendered incapable of making their escape, even when there is no fire to obstruct them. He recommended, among the means of escape which inhabitants of houses may always have in readiness for themselves, an apparatus invented by Lieut. Cook, consisting of a cylindrical canvass bag, which is kept in its proper form by a circular wooden bottom, and a strong ring of iron at the top. This bag is suspended by a rope, which passes over a pulley, hooked to an iron bolt previously fixed to the brick-work; and the end of the rope being thrown into the street, is seized by the persons below, who lower the bag with the individuals it may contain through a circular hole in the bottom of a balcony which is attached to the window. Even without assistance from below, a person may lower himself in safety by winding the rope round the balcony; and, as the whole apparatus lies in a small compass, it may be kept in a room without inconvenience. In treating of the various inventions intended for facilitating escape in cases of fire, and mentioning with applause the contrivances of many ingenious individuals, Dr. Birkbeck said, that the rope-machines of Mr. Rider and Mr. David Davies were admirable contrivances of the kind, and, with slight exceptions, were nearly perfect. That of Mr. Rider consisted of a strong hempen rope, sallied with worsted, like a common bell-rope, and having at its upper end a swivel ring, with a spring catch, which might be instantly fixed to a bed-post, a chest of drawers, &c. By means of this machine, a person descended in perfect safety from the gallery to the platform, holding by the rope, and standing upon a kind of iron stirrup, with three rings through which the rope passed. These rings were not placed perpendicularly above each other, but stood in such directions as to cause a considerable degree of friction, and to prevent the too rapid descent of the person using the apparatus. A contrivance was connected with it, for instantly fixing a secure noose under the arms, to be used when the friction seat attached to the machine (by which a person might even descend, holding another in his lap) was not employed. Another appendage to the apparatus was a ramp-iron (to be fixed into the sill of the window) with a fork, over which the rope was intended to pass, to prevent it from receiving injury while in use.

Fire-escapes are various, but as they are never on the spot when wanted, a knotted rope fastened to the larger furniture, and the beds thrown out to fall upon, are the means which are or ought to be always present. Suffocation from smoke may be avoided by crawling on the hands and knees, and keeping the face near the floor.

FIRES IN FACTORIES.—Mr. T. Waterhouse has communicated a series of experiments.

1st.—That steam will extinguish a large conflagration in a close apartment in five minutes, when it is driven into the room in considerable quantity.

2d.—That it does not possess the power of preventing a low or charring combustion.

3d.—That when a current of steam is impelled against a large fire, it increases the combustion in a remarkable degree.

4th.—That a small flame is almost immediately extinguished when suspended in an open apartment into which a considerable volume of steam is rushing.

5th.—That steam will subdue flame in an open room as rapidly as in a close one.

FIRE-PROOF BUILDINGS. The principal cause of the destructiveness of fires in large buildings, is the want of arched surfaces of incombustible materials. The use of arched surfaces of solid materials cannot, therefore, be too strongly recommended. In no part of our church architecture is the skill of the contrivers so conspicuous, as in the art employed in the construction of the vaulting, in order to procure strength and reduce the lateral pressure, which they effected by a framework of stone, of sufficient depth, converging towards the points of support, and by filling in the intervals with thinner material.

A very frequent occasion of fire is the necessity for the repair of lead gutters, which requires the use of braziers on the roof. This necessity would, in a great degree, be obviated by the adoption of gutters of cast-iron, or of solid lead cast in troughs, and having spouts at proper intervals to carry off the water. The action of the sun upon gutters, which, by expanding the metal, is the principal cause of their failure, might also be much diminished by a thin covering of stone or slate, sufficiently perforated for the percolation of water. This contrivance would also have the advantage of preventing the lodgment of snow, which is apt to freeze in the gutters and occasion the water to overflow, to the damage of the building, and particularly to the timbering of the roof.

It is another cause of fire that the use of roofs are of timber, especially when connected with the roofs of other buildings. In such cases, the substitution of iron for wood would afford security; and if, in the use of iron, care is taken to make the rise or pitch of the roof sufficient to prevent indirect strains, and to *tie in* the feet of the main supports or triangles, there can be no danger of failure, provided the strength of the iron is proportioned to the weight it has to carry. If, however, the building has an arched under-roof of solid materials, and care is taken to prevent the necessity of continual repairs to the lead-work, the danger of fire, even from a roof of timber, is very considerably obviated.

The means which may be recommended for securing such valuable collections of books or works of art from destruction by fire, are, in the first place, to use *incombustible materials* in the construction of the buildings containing them; and, secondly, to subdivide these collections into suites of separate rooms, which may be connected by wide and high *doors of metal*, rendered ornamental by plates of bas-relief, made to open upon pivots, and poised with mechanical skill, so as to be easily moved. By these precautions, should a fire unfortunately destroy the contents of any one room, it might be prevented from extending to the adjoining apartments.

It is not here intended to enter further into the details of construction; or to refer to the use of arches upon cast-iron beams and sheets of metal, &c.; but it is desirable to explain, that an excellent surface for interior finishing may be obtained, by using, instead of lath and plaster, a lining of brick detached from the exterior walls. This not only affords a security against fire, but has the additional advantage of interposing a medium of air between the inner and outer walls, which, by its slow conducting power, will prevent the interior of the building from partaking of the variations of the outer atmosphere, and consequently, in cold weather, will avoid the precipitation of moisture on the inner walls.

As flame only *ascends*, care should be taken that combustible materials do not join from the bottom to the top of any building. Stair-cases, window-frames, and doors of wood spread fires.

FISHES; animals which live in the water, with red, cold blood, with cartilages or bones, with fins instead of limbs, and which inspire and expire air, in combination with water, by means of gills, instead of lungs.

According as fishes have cartilages, or a bony structure, they are divided into *two* general classes.

The *cartilaginous* fishes, which either have or have not a gill-cover. To the latter kind belong the lamprey, the ray, and the shark; to the former, the sturgeon, the porcupine-fish, the sea-needle, the eel, and the sword-fish.

The *bony* fishes are divided into orders, according to the position of the ventral and thoracic or pectoral fins. In the eel-pout, the Baltic dorse, and the haddock, the ventral fins are placed before the pectoral: they are directly under them in the bream, the perch, the perch-pike, the mackerel, and the river-perch, and behind them in the salmon, the pike, the herring, and the carp. In the structure of fishes, the fins are remarkable as being the only organs of motion. They consist of bony rays, covered with the epidermis, and attached to certain cartilages or bones, which are moved by particular muscles. The tail, with its fin, serves as a rudder, to give the proper direction to the motions of the animal. The first impulse in swimming evidently comes from the tail; the other fins serve to regulate the position of the fish, and to guide him in his different motions. The muscles of fishes must be distinguished from the flesh muscles of warm-blooded animals. They consist of white or light-coloured layers, with fibres of a thicker texture than those of warm-blooded animals; between these layers there is a white, gelatinous substance, which grows putrid very soon after death. If we look at the organs of sense and the nervous system in fishes, we cannot but remark the extraordinary smallness of the brain in proportion to the size of the body. In man, the brain is 1-23 of the body; in the shark, it is 1-2500, and in the tunny-fish, 1-37,400; it is also less solid than in warm-blooded animals, and consists mostly of lumps resembling ganglions. The cerebellum is only a transverse plate, entirely without the structure, which, in higher orders of animals, is called *arbor vitæ*.

The nerves of fishes are weaker than those of the higher animals: some of them, however, are such powerful exciters of electricity, that they can give violent shocks: but the power ceases as soon as the nerves are cut. The torpedo, the gymnotus, the electric eel, the Indian-needle, and the electric porcupine-fish, are five fishes which appear to be living Voltaic piles; for they have two muscular piles, separated from each other by a membrane resembling a net, and which, at least in the torpedo, lie under the curved cartilages of the large side-fins, and are regulated by particular nerves. As to the organs of sense in fishes, those of smelling and seeing appear to be the most perfect. Fishes smell the bait farther than they can see it, and the shark perceives, at an incredible distance, the odour of a Negro. Their organs of smell have no connexion with those of respirations; and the water apparently conveys the effluvia affecting the sense of smell much less perfectly than the air; but they have very large olfactory nerves, the ends of which were for a long while taken for the true brain.

The respiration of fishes is carried on by means of their gills; these are well known to be vascular membranes, four on each side, fastened to a curved and flexible cartilage. They are connected with the cartilages of the tongue, and with the cranium. In cartilaginous fishes, the gills are within the body like bags, and a determinate number of external openings lead to them; the lampreys, and that kind called the *nine eyes*, have seven, rays and sharks five of these openings. Several fishes have also a peculiar covering for the gills, and frequently a membrane over them, which can be contracted or extended. It encloses a number of winding cartilages, which are called its *rays*. The gills, as is very evident, can only receive the air which is mixed with the water. What is called the *air-bladder* is, in most fishes, joined by an air-pipe to the stomach or throat. This is thought to contain nitrogen; but it is certain that it assists their rising in the water. Several fishes, as the loach and gudgeon, breathe also through the excretory duct, as is fully proved. The ling are even discovered, when at the bottom of the sea, by the rising of air-bubbles.

The circulation of the blood in fishes is different from that of the higher classes of animals. The heart consists only of one auricle and one ventricle; it receives the blood from the body, and sends it, by a single artery, directly to the gills; it is here provided with oxygen by contact with water, and the air contained in it, and is again received by a number of small vessels, which flow together into the aorta, which distributes the blood over the whole body. The motion of the heart is, in fishes, much more independent of the brain and spinal marrow than in the higher orders, and, for this reason, can continue several hours after the brain and spinal marrow have been destroyed. The chyle produced by the digestion of fishes is received by absorbing vessels, which terminate immediately in the veins, without going through glands. Although most fishes lay eggs, which are matured and hatched out of their body, there are cartilaginous fishes which are viviparous.

FIXED OILS, are two specimens of oil in vegetables, agreeing in the common properties of unctuosity and inflammability, but essentially different in many of their chemical qualities. The one capable of being volatilized without decomposition, is named *volatile oil*, the other is *fixed oil*.

The latter is generally contained in the seeds and fruits of vegetables, and varies in its properties, according to the plants from which it is obtained by pressure, and frequently called *expressed oils*. When the process is aided by heat, the action of which is to render the oil more fluid, the product is esteemed less pure. The purest fixed oils are those expressed from the fruit of the olive, or the seeds of the almond; others, less pure, come from the flax-seed and hempseed. These oils are usually fluid, but of a somewhat thick consistence, and liable to congeal at very moderate colds; palm-oil is even, naturally, concrete. When fluid, they are transparent, of a yellow or yellowish green color, and capable of being rendered quite transparent by the use of animal charcoal. They are inodorous and insipid, at least if they have been obtained with due care; and free from the mucilaginous and extractive matter of the plants from whence they come; are lighter than water, with which they do not unite, and are very sparingly soluble in alcohol, with the exception of castor-oil. At a temperature below 600° Fahr., they remain unchanged.

Near this temperature, however, they begin to boil, and to disengage an inflammable vapor; but the oil thus condensed is altered in its properties; it loses its mildness, becomes more limpid and volatile, a portion of carbon being likewise deposited. Transmitted through an ignited tube, fixed oil is converted into carbonic acid and carbureted hydrogen, with a small portion of acid liquor, and a residuum of charcoal. In the open air, it burns with a clear white light, and formation of water and carbonic acid gas. Accordingly, the fixed oils are capable of being employed for the purposes of artificial illumination, as well in lamps as for the manufacture of gas. Fixed oils undergo considerable change by exposure to the air. The rancidity which then takes place is occasioned by the mucilaginous matters which they contain becoming acid.

From the operation of the same cause, they gradually lose their limpidity, and some of them, which are hence called *drying-oils*, become so dry, that they no longer feel unctuous to the touch, nor give a stain to paper. This property, for which linseed-oil is remarkable, may be communicated quickly, by heating the oil in an open vessel. The drying-oils are employed for making oil-paint, and, mixed with lampblack, constitute printers' ink.

During the process of drying, oxygen is absorbed in considerable quantity. This absorption of oxygen is, under certain circumstances, so abundant and rapid, and accompanied with such a free disengagement of caloric, that light, porous, combustible materials, such as lamp-black, hemp, or cottonseed may be kindled by it. Many instances of spontaneous combustion have occurred from this cause. It appears that if hemp, flax, or linen cloth, steeped in linseed-oil, lie in a heap, and be somewhat pressed together and confined, its temperature rises, a smoke issues from it, and, at length, sometimes within 24 or even 12 hours, it takes fire. The same thing happens with mixtures of oil and fine charcoal, and with lamb-black wrapped up in linen; from whence it is conjectured, that many extensive fires, which have broken out in cotton manufactories, and for which no cause could be assigned, must have arisen from this spontaneous inflammability of oils.

Fixed oils unite with the common metallic oxides. Of these compounds, the most interesting is that with the oxide of lead. When linseed-oil is heated with a small quantity of litharge, a liquid results which is powerfully drying, and is employed as oil-varnish. Olive-oil, combined with half its weight of litharge, forms the common *diachylon plaster*. The fixed oils are readily attacked by alkalies. With ammonia, they form a soapy liquid, to which the name of *volatile liniment* is applied.

They are oxidated by a number of the acids. Sulphuric acid soon renders them black; the oxygen of the acid attracting part of the hydrogen of the oil, and causing the deposition of charcoal; and, if heat is applied, a large portion of sulphurous acid is disengaged, and even sulphur is evolved. Nitric acid renders them thick; if heat is applied, the action is more rapid, and a yellow color is communicated, the oil being rendered concrete. Chlorine thickens oil, and renders it white.—When boiled in sulphur, a compound is formed of a brown color, a very fetid smell, and acrid taste. It likewise, when heated, dissolves phosphorus, forming a liquid which becomes luminous, when exposed to the air. Olive-oil consists of carbon 77·213, oxygen 9·427, and hydrogen 13·360.

FIXITY, FLUIDITY, VAPOUR, AND GAS, are words expressive of the various conditions of the atoms of bodies. *Fixity* is a relatively passive state, in which the atoms have no active dispersive motion, but are patients of the pressure of the atmosphere of 15 lbs. to the square inch, thereby forming solid, fixed, or concrete masses. FLUIDITY is an active state, created by motions imparted to the atoms of solids, but equal to the atmospheric pressure of 15 lbs. to the square inch. At the same time, there are, in all fluids, certain parts which break up first, or which are more susceptible of internal motion; and these, overcoming the 15 lbs. of general pressure, rise into vapour before the mass, as in all distillations, &c. &c. VAPOUR is the conversion of a solid or fluid into a rare state, by internal or imparted motions exceeding the pressure of 15 lbs. to the square inch, and this condition may arise before the internal motion is so great, owing to the separation of the parts. The next state is that of GAS, which is distinguished from vapour by its greater permanency, or by its accordance with the atoms which form the permanent gases, and whose united excitements or motions create the atmospheric elasticity, or uniform pressure of 15 lbs. to the square inch. These four states of matter, intermingled with varieties in the atoms, as to action and reaction, constitute all bodies and their phenomena; and, in reasoning on causes and effects, they are our only standard of reference.

FLAMBEAU.—A kind of large taper, made of hempen wicks, by pouring melted wax on their top, and letting it run down to the bottom. This done, lay them to dry, after which roll them on a table, and join four of them together by means of a red-hot iron; and then pour on more wax, till the flambeau is brought to the size required.

FLAME, is considered as ignited vapour, or red-hot smoke. It always consists of volatile inflammable matter, in the act of combustion, or of combination with the oxygen of the atmosphere. Many metallic substances are volatilized by heat, and burn with a flame, by the contact of the air in this rare state. Sulphur, phosphorus, and some other bases of acids, exhibit the same phenomenon. The flames of organized substances are in general produced by the extrication and ascension of hydrogen gas, with more or less of charcoal. When the circumstances are not favorable to the perfect combustion of these products, a portion of the coal passes through the luminous current unburned, and forms smoke, and soot is the condensed matter of smoke.

As the artificial light of lamps and candles is afforded by the flame they exhibit, it seems of considerable importance to ascertain how the most luminous flame may be produced with the least consumption of combustible matter. The light emitted is greatest when the matter is completely consumed in the shortest time. It is therefore necessary, that a stream of volatilized combustible matter, of a proper figure, at a very elevated temperature, should pass into the atmosphere with a certain determinate velocity. If the density of this stream be too thick—its internal parts will not be completely burned, for want of contact with the air. If its temperature be below that of ignition, it will not burn when it comes into the open air. And there is a certain velocity, at which the quantity of atmospherical air which comes in contact with the vapour, will be neither too great nor too small; for too much air will diminish the temperature of the stream of combustible matter so much as very considerably to impede the desired effect; and too little wlll render the combustion languid. We have an example of a flame too large, in the mouths of the chimneys of furnaces, where the luminous part is merely superficial, or of the thickness of about an inch or two, according to circumstances, and the internal part, though hot, will not set fire to paper passed into it through an iron tube: the same defect of air preventing the combustion of the paper as prevented the interior fluid itself from burning. In Argand's lamp, an internal current of air renders the combustion perfect, by the application of air on both sides of a thin flame. So, likewise, a small flame is whiter and more luminous than a larger; and a short snuff of a candle, giving out less combustible matter in proportion to the circumambient air, the quantity of light is increased eight or ten times.

Flame is red-hot smoke, or vapour. A body may be red-hot, as iron, and yet not flame, which is a mere phenomenon of tenuity, or visible distributed heat. Again, vapour may be too dense for the heat to make it flame, or soon may become too cool. Certain conditions are necessary, as access of oxygen, which the distribution in the space favours, and hence red-hot vapour makes flame, while red-hot iron does not make flame. In both cases, the excitement creates the diffused action called light, which, by Dr. Young's experiments, appear to be waves of atomic motions, or motions of the atoms in the space.—*See* FUEL, *&c.*

Vogel gives the following rules for colouring the flame of spirits of wine either yellow, red, or green. A *yellow* flame is produced by setting fire to the spirits over salt, of which the bases may be either ammoniac or soda, manganese, iron, mercury, platina, gold, nickel, cobalt, or bismuth. A *red* flame is obtained by making use of salts, the base of which is either lime, or strontian, or lithine, or magnesia. If the spirits are burnt over salts of copper, uranium, or alumine, a *green* flame is obtained. All the salts made use of should be soluble in alcohol. A *green* flame is also to be procured by dissolving in the alcohol boracic acid, or weak hydrochloric ether.

FLASH.—*(To colour, and add warmth to Brandy and Rum.)* Mix extract of capsicum with sugar.

FLAX, *(linum usitatissimum)* has been cultivated from remote antiquity, and it is found wild in Persia. The root is annual; the stem, slender and frequently simple, from 18 inches to two feet high. This plant is cultivated principally for the fibres yielded by the bark, of which linen cloth is made.

The seeds are mucilaginous and emollient, and an infusion of them is often used as a drink in various inflammatory disorders: they also yield *linseed-oil*, which differs, in some respects, from most expressed oils, as in congealing in water, and not forming a solid soap with fixed alkaline salts. This oil has no remarkable taste, is used for lamps, sometimes in cookery, and also forms the base of all the oily varnish made in imitation of China varnish. It is much employed in the coarser kinds of painting, especially in situations not much exposed to the weather. Equal parts of lime-water and linseed-oil form one of the best applications for burns. The cakes remaining after the oil is expressed, are used for fattening cattle and sheep.

Flax-seed has been substituted for grain in times of scarcity, but it is heavy and unwholesome.

In Europe, it is generally sown in the spring, from March to May; sometimes, however, in September and October. In a dry and warm country, it is better to sow in autumn, as the rains of autumn and winter favour its growth. In cold and moist countries, sowing should be deferred till late in the spring, as too much moisture is hurtful. A light soil is the most suitable, though good crops are obtained from strong and clayey grounds.

As it appears to degenerate when repeatedly sown without changing the seed, it is usual, in some countries, to import the seed from the north of Europe; particularly from Riga, which affords the best. The American seed, also, bears a high reputation, and, in Ireland, is preferred for the lighter soils, and the Baltic for the more clayey.

There are three varieties of flax: the first produces a tall and slender stem, with very few flowers, ripens late, and affords the longest and finest fibres; the second produces numerous flowers, and is the most proper for cultivation, where the seed is the object; but its fibres are short and coarse; the third is the most common, and is intermediate between the other two. It is important not to mix the seeds of these three varieties, as they ripen at different periods; and, besides, the first should be sown more closely, and the second at greater intervals than the third. When it is a few inches high, it should be freed from weeds, particularly from the cuscuta, a parasitical plant, consisting of yellowish or reddish filaments, and small white flowers: all the stems which have this plant attached to them should be pulled up and burnt. To prevent its lying on the ground, it is usual with some to stretch lines across the field, intersecting each other, and fastened at the intersections.

As soon as it begins to turn yellow, and the leaves are falling, it is pulled, tied together in little bundles, and usually left upright on the field till it becomes dry, when the seeds are separated, either by beating on a cloth, or by passing the stems through an iron comb. The stems, after being placed even at the base, are again tied together in bundles for rotting—a process which is necessary to facilitate the separation of the fibres, and which is accomplished in three different manners: 1st, on the earth, which requires a month or six weeks; 2d, in stagnant water, which is the most expeditious manner, as only ten days are necessary; but the fibres are of inferior quality; 3d, in running water, for which about a month is necessary. The finest fibres are produced by this latter mode, and certain rivers are considered as possessing advantages over others. It is necessary to turn it every three or four days.

After this process, it is taken out, dried, and is ready for obtaining the fibres. For this purpose, a handful is taken in one hand, laid upon a table, and beaten with a wooden instrument, afterwards drawn forcibly over the angle of the table with both hands, in order to free it from fragments of the stem. It is afterwards heckled or combed with a sort of iron comb, beginning with the coarser and ending with the finer, and is now ready for spinning, in which similar machinery is used to that for cotton.

Mr. Emmett immerses flax in water in which charcoal has been infused, and the water should appear clouded by the charcoal upon being well shaken. Half an ounce of charcoal is used to 6 or 7 lbs. of flax. In order to bring the charcoal in contact, the flax should be pressed under it several times a day, and the liquid well agitated. After 20 or 24 hours, the flax, when taken from the liquid, should be well wrung, and then put into a second vessel of water containing less charcoal, agitated and pressed down as before. If this process is well conducted, two or three days will be found sufficient. It should then be spread thinly on grass, taking care to turn it frequently for a few days. The flax must then be rinsed in river-water, and washed thoroughly with soap and hot water, till it is quite clean. The soap must then be washed out with cold water, and the flax dried, exposed to the sun and air.

The following observations on Flax-spinning were written by Sir Richard Phillips, during a visit to Leeds, in 1828:—" The manufactures of Leeds consist of two great staples, Wool and Flax, and a monopoly of two articles of such universal consumption, of course, creates one of the greatest accumulations of employment, within the same space, in the civilized world. Leeds not only makes woollen cloths in all varieties, and exhibits every detail of the manufacture, from the undressed fleece to the finished piece for the tailor's shears, or, in fine stuffs for the mantua-maker; but, it is the chief place where the Flaxes of Russia and the Netherlands are spun into thread for every kind of linen fabric.

" The first flax and linen manufactory which I visited was that of Messrs. Benyon, and I preferred it to some others, because it includes both the spinning and the fabric, and is itself of gigantic dimensions. Persons used to see the large cotton-mills in Lancashire and Derbyshire may understand the extent of the great flax-spinning-mills of Messrs. Marshall and Sons, Messrs. Benyon and Sons, Messrs. Hives and Atkinson, and Messrs. Titler, Tatham, and Walker, at Leeds.

" Flax is purchased by the Leeds spinners at Hull or London, and often is imported by them directly from Riga, Rotterdam, or Antwerp. The prices of undressed Russia flax were, in November 1828, about 38*l*. or 40*l*. per ton, and of Flemish from 40*l*. up to 100*l*. It had been falling in the market for some years. During the war, Baltic flax sold at above 100*l*. a ton; but since the peace it fell to 50*l*. or 60*l*. and since the fatal Panic, has fallen as above, and even lower. Flemish flax, before the late war, was little used in British manufactures; but the increased consumption, since the discovery of its great superiority, has enabled the dealers to maintain their prices. Irish flax has also been imported and spun at Leeds; but latterly, the Irish crops have failed; while the competition of foreign flax and the corn-laws, operating as a bounty on the growth of grain, have rendered it less worthy of cultivation in Ireland. Much flax was, till lately, grown in Yorkshire, but the low prices of foreign flax have led to its abandonment. It is, moreover, an exhausting crop, and requires high prices when cultivated at English rents, though, in a public sense, it is desirable, because it involves more human employment than corn crops.

" In such a manufactory as that of Messrs. Benyon, the flax is first dressed or *hackled*; *i. e.* is drawn through or over cylinders, covered with points, so as to divide the fibres, and prepare it for spinning or drawing out into a *sliver*.

" It is then spread on a frame and roved or drawn, in a loose way, into slivers, preparatory to being drawn through rollers, into lengths of successive degrees of fineness, exactly on the principle of cotton-spinning. It is now ready for the spinning-frame, and spun into yarn, in hanks or *leas*, as they are called in this trade.

" A lb. of it is divided into so many leas, each 300 yards long; and the number of leas is the commercial name or number of the thread. Messrs. Benyon spin from No. 1 up to 60; but their usual Nos. are from the heaviest, or Nos. 2 and 3, to 40. The low numbers are used for sail-cloth, sacking, &c. and sold, at present, from $3\frac{1}{2}d$. to 12*d*. per lb.; the higher numbers, from 20 to 40, are used for sheeting, drills, table-cloths, &c. &c. and sold from 1*s*. to 3*s*.

" Irish linen, or shirting, is made in Ireland, I was told, from numbers which range, according to fineness, from 60 to 100 or upwards; while cambrics require Nos. 120 to 200. Messrs. Marshall, and Messrs. Hives and Atkinson, spin up to 120, and Mr. Hives shewed me a specimen of No. 200, spun in his superior machinery. 200 *leas*, at 300 yards, is 34 miles for a lb. of flax!

The prices of 100 are 6*s*. to 7*s*. and of 60 are from 3*s*. 6*d*. to 3*s*. 10*d*. per lb. For low numbers, the Baltic sorts are chiefly used, and now cost about 4*d*. per lb.; but, for high numbers, the Flemish, which is worth from 6*d*. to 1*s*., and by comparing these prices with the prices of yarns of different numbers, the produce of the labour and machinery of spinning may be estimated.

"It is supposed, that, for some years, the weekly quantity of flax spun in Leeds is from 100 to 120 tons, of which about two-thirds is Baltic. The several flax-spinning mills, and the weaving in and near Leeds, are believed to give employment to about 5000 men, women, boys, and girls.

"The machinery is all made and repaired on the spot, and these great manufactories have a *smithery* for repairs, while the machinery is made by Cawood and Sons, and some others in Leeds, whose workshops are among the most interesting curiosities of this noble town. The Cawoods not only make the machinery of Yorkshire, but they export largely to all parts of the world.

"In passing through the extensive buildings of Messrs. Benyon, I saw the raw flax hackled, or combed, by means of hexagonal rollers, armed with pins and pulled by boys. It is then drawn out, in another floor, into coarse slivers, and from slivers into rovings or lengths slightly twisted. These are afterwards carried on their bobbins to spinning-frames, and by them drawn out to required lengths, between rollers of different sizes, which move with different velocity, a slow roller arresting the threads, so as to increase the original length of the roving, in any required proportion, and spin or twist it at the same time, exactly like cotton-spinning.

"In coarse sorts the number of twists in an inch are but three or four; but in No. 60 there are eleven twists to an inch. The spindles in this last No. revolve 2100 times in a minute, and in No. 60 and upwards, the roving is drawn through water at a temperature of about 120°. The thread is then combined from the bobbins, by reels, into warps, for various purposes, or, when required to be bleached, is reeled off into hanks of 100 threads, each of which is three yards, forming a lea of 300.

"In another part of the premises I saw weaving performed for hop-bagging, with waste flax of No. ½, and also sacking and sail-cloth; and was informed that a good hand will weave 30 or 40 yards per day of sacking, and 20 yards of sail-cloth; the wages for which are about 2*s*. 6*d*. Women are chiefly employed at the spinning-frames, at 6*s*. per week, superintending 100 bobbins; and there are about 8000 in three floors. In the cost of machines, every bobbin is valued at about 30*s*.

"The manufactory of Messrs. Benyon spins about nine tons per week, or 300 bundles, each containing 200 leas; and the whole, 260,000 leas, which, at 300 yards each, gives 78,000,000 of yards per week. A 30-bobbin frame makes 150,000 yards per day or 500 leas; and a 60-spindle about one-half more. It is computed that 80,000 spindles are always at work in and round Leeds, being 11 times the quantity spun by Messrs. Benyon, making, on different numbers, about 780 millions of yards of flax yarn per week. Messrs. Marshall and Co. spin about 26 tons per week, and work 13,000 spindles, or 2 tons for every 1000 spindles, or 43 lbs. per week per spindle. Their premises are equal to Somerset House in dimensions, with five floors, very black and very ugly, and they employ about 700 hands.

"The spinning-factory of Messrs. Hives and Atkinson is the handsomest building, of this description, in Leeds, and, like the others, of great extent. This house, and that of Messrs. Marshall, have lately carried fine spinning to unprecedented perfection. They used to rise no higher than 40 or 50 leas, but they now expand their threads to 100 or 120, and thereby prepare superior yarn, even for the Irish linen manufactory, thus striking out a new trade, and acquiring extensive orders from the linen counties in Ireland. I learnt that a frame of 96 spindles, in Mr. Atkinson's factory, spins about 5 lbs. per day, at 100 leas, which is 150,000 yards. Down to this time, 15 leas was the average production of these several factories; but I saw, in the splendid works of Messrs. Marshall, the first of the kind in the world. Rooms full of frames, which spin from No. 100 and upwards."

In a late number of Curtis's Botanical Magazine, an interesting and curious description of the *fermium tenax*, or New Zealand flax, is given. It seems that this vegetable fibre is capable, at some future time, of becoming an article of vast importance. The importation is progressively so increasing, as to warrant the idea of its becoming one of the staple commodities of import from the Southern Hemisphere. From the Custom House returns, it appears that, in 1830, 841 tons of it was imported, and, in 1831, 1062 tons, at from 15*l*. to 25*l*. per ton. Mr. Curtis's statement of the relative strength of the fibre, as compared with flax and hemp, is, that flax breaks under a weight of $11\frac{3}{4}$, hemp $16\frac{3}{4}$, New Zealand flax $23\frac{7}{11}$, while silk will only bear 24, so that is nearly the same strength as silk. But for the injustice and cruelties practised against aboriginals by intruders, we could wish that New Zealand might become a European colony.

FLESH.—The several kinds of flesh, fish, and white of egg, contain 12 or even 13 oz. of water, and the 3 or 4 oz. of solid matter is about one-fourth gelatine, and the remainder, albumen, left undissolved, when the solid matter obtained either by drying with heat, or by oil of vitriol in a vacuum is boiled in water.

What is called flesh, or meat, is, in truth, nothing more than the muscle of the animal, which, when washed and dried, consists of fibres, like flax; consequently, not above one oz. in a lb. is assimilatory nutriment, while the fibrous structure renders all flesh very hard of digestion.

FLEUR DE LUCE.—The fresh root is hydragogue and errhine; and, externally, it repels eruptions.

FLINT, a mineral, which occurs of all colours, and is widely spread throughout the earth, in primitive, secondary, and alluvial formations, but especially in lime-stone. This mineral consists of 98 silica, 0·51 lime, 0·25 alumine, 0·25 oxide of iron, and 1·1 loss. Its principal use is for *gun-flints*, and it is also reduced to a powder, and used in the manufacture of porcelain and glass.

The manufacture of gun-flints is exceedingly simple, and a good workman will make 1000 a day. The art consists in striking the stone repeatedly with a kind of mallet, and bringing off, at each stroke, a splinter sharp at one end, and thicker at the other. The splinters are afterwards shaped at pleasure, by laying the line at which it is wished they should break, upon a sharp instrument, and then giving it small blows with a mallet.

The origin of flint is a geological difficulty, and, as well as chalk, both must have been produced by states of the earth and atmosphere, which we can only imagine, and not prove by present facts. It is generally supposed, that they are the concretion of organic remains.

Flint and steel are struck together to produce light. Particles of the steel are struck off, hot enough to become incandescent, and, on examination, are found to be oxydized as a true combustion. A horse's shoe struck against a flint produces the same effect.

FLINT-GRINDING, is a mechanical process, indispensable in the manufacture of earthenware and porcelain. The flint nodules, from Ireland and the south coast, are calcined in small kilns (formed similarly to lime-kilns.) While hot they are thrown beneath the *stampers*, a set of vertical beams, whose ends are shod with iron, and which are lifted up by the crank of a shaft, and fall on the nodules, the fractured portions falling through a grate. These are thrown into a circular vat, 10 to 15 feet in diameter, the bottom paved with blocks of chert stone, the horn-stone of Jameson. In a step in the centre is placed the axis of a vertical strong wooden shaft, on the upper end of which is a crown spur-wheel, for the requisite motion from a steam-engine or water-wheel. At right angles this shaft has an arm, each with a ledge, to bear other blocks of chert. The whole being put in motion, the abrasure of the calcined flints is promoted by that of the chert among the water, and is continued until the mass is a pulpy fluid, and a pint measure of it weighs not less than 32 oz. The Cornish stone is ground in a similar manner, and the pulpy fluid is not less than 33 oz. the pint measure. One ton of good nodules should grind into 120 pecks of flint pulp.

Flints are also reduced to fine powder, by heating them red-hot and quenching them in water.

FLOUR of Fine Wheat, *(farina tritici.)* The *finest* flour, obtained by sifting the first grinding of wheat, by a sieve of 64 wires to the inch, is used for pastry.—*Middlings* are the remaining flour of the first grinding, that pass through a coarser sieve; used for household bread, (but it is mostly reground.) —*Seconds*, are the finest part obtained by regrinding middlings between blunt stones: used for bakers' fine wheaten bread.—*Pollard* is the coarse flour, from the seconds, and is used for sea-biscuits and gingerbread, and to fatten poultry and hogs. Accum says 32 bush. of wheat yield 38½ of flour, 8 of pollard, and 12 of bran; the bulk of the wheat being nearly doubled by grinding.-*Country household flour* is usually ground only once, and sifted to 4-5ths of the weight of the wheat. *Ammunition flour* is ground and sifted to 1960-2280ths, or very nearly 5-6ths the weight of the wheat.

Baked Flour is astringent; and used to make food for infants that are purged.

Rye Flour, *(farina secalis,)* is used for either a sweet bread, raising the dough by yeast, or an acid bread by using leaven; this last is cooling, and more suited to animal diet.

Barley Flour, *(farina hordei,)* when made into dough with yeast, requires to be baked very soon, as it quickly becomes sour. By a paste of barley-meal and water, the hair is taken off skins, prior to being tanned.—*Scotch barley-meal*, made from big, or bear, dark coloured.—*Prepared pearl-barley* is pearl-barley, highly dried, and then ground, and used to make barley-water and gruel.

Oatmeal, *(farina avenacea,)* is used to make gruel and bread.

German Rice Flour, made rfom

German rice, or naked barley, is used to thicken soups, but potatoe starch is often sold for it.

Potatoe Flour is made from boiled potatoes, but is not soluble in water, and is manufactured into sago, salep, maccaroni, vermicelli, semolina, and tapioca.

FLOWERS for distillation, &c. should be gathered in bloom, and dried speedily. Take off the calx, claw, &c., but in small flowers the calyx may be left, or even the flowering spike, as in labiates. Flowers, with pappous seeds, such as coltsfoot, should be dried high and before opening. Flowers without smell may be dried at 75° or 100°; but liliaceous plants, whose odour flies, cannot be dried. Several sorts, as lesser centaury, wormwood, melilot, &c. may be tied and hung up, or exposed to the sun, and then wrapped in paper. Blue flowers become yellow or discoloured, unless dipped in boiling water, and squeezed before they are dried.

Flowers in water, and living plants in pots, greatly injure the purity of the air during the night, by giving out large quantities of an air (carbonic acid) similar to that which is separated from the lungs by breathing, which, as is well known, is highly noxious. On this account they should never be kept in bed-rooms.

*To procure Flowers in Winter.*—A branch, proportioned to the size of the object required, is sawn off the tree whose flowers are to be produced, and is plunged into a spring, where it is left for an hour or two, to give time for ice to melt, and to soften the buds; it is then carried into a chamber heated by a stove, and placed in a wooden vessel, containing water; quick-lime is to be added to the water, and it is left for 12 hours. The branch is then to be removed into another vessel, containing fresh water, with a small quantity of vitriol, to prevent its becoming putrid. In a few hours the flowers will begin to appear, and afterwards the leaves. If more quick-lime be used, the flowers will appear quicker; if none be used, the branch will vegetate more slowly, and the leaves will precede the flower.

FLUID, is the name given to all bodies which yield, without separation, to the slighest pressure. All fluids, except those in the form of air or gas, are incompressible; and all fluids weigh in proportion to their quantity of matter, not only in the open air, or in vacuo, but in their own elements. The particles of a fluid, at the same depth, press each other equally in all directions. This appears to rise out of the very nature of fluids; for, as the particles give way to every impressive force, if the pressure amongst themselves should be unequal, the fluid could never be at rest, which is contrary to experience; therefore, we conclude that the particles press each other equally, which keeps them in their own places.

A solid body may be converted into a fluid by heat. The less the temperature at which this is effected, the more fusible the body is said to be. All fluids, not excepting the fixed metals, appear, from various facts, to be disposed to assume the elastic form, and this the more readily the higher the temperature. When a fluid is heated to such a degree that its radiating force is greater than *the pressure of the air*, its interior parts rise up with ebullition.

All the phenomena of fluidity prove the intimate operation by motion. A solid is broken up by motion called heat, and converted into a liquid. The liquid remains so, owing to the pressure of the gas of the atmosphere, and then more motion or heat being imparted, it overcomes the atmospheric pressure, and also becomes gas. There would be no liquid, but for atmospheric pressure.

FLUOR-SPAR, is the crystal and crystalline masses of a mineral, in regular octahedrons. It presents an extensive variety of crystals, of which the cube and the cubo-octahedron are the most frequent. They vary, in size, from very minute to several inches in diameter. Lustre, vitreous; colour, white, though not very common, and seldom pure; more generally wine-yellow or violet blue. Among its brightest colours are emerald and pistachio-green, sky-blue, rose-red, and crimson-red. Very dark blue colours, bordering on black, and probably owing to foreign admixtures, sometimes occur. Fluor is composed of 72·14 of lime and 27·86 of fluoric acid. Before the blowpipe it decrepitates, and becomes phosphorescent, but loses its colour, and melts, at last, into an opaque globule. It phosphoresces, likewise, if thrown upon ignited charcoal or heated iron. The light emitted is generally purple, though some varieties afford bright green colours.

Sulphuric acid decomposes the powder of the mineral and fluoric acid that is disengaged in a gaseous state. Several varieties, particularly the sky-blue and rose-coloured ones, lose their colour on exposure to the light. Fluor is not unfrequently found in beds, as at Alston Moor and Castleton; more generally, however, it occurs in veins in argillaceous schist and secondary limestone, accompanied by galena-blende, calcareous and pearl spars, heavy spar, quartz, bitumen, and clay.

The uses of fluor are numerous and important. It is employed as a flux in the reduction of various ores, from which circumstance the name *fluor* has been derived. The fluoric acid, disengaged from it by means of sulphuric acid, is used for corroding and etching upon glass. Formerly the finest specimens were cut and worn as gems; but their inferiority in point of hardness, being considerably below that of the artificial gems, has brought them into disuse. It still continues, however, when obtainable in masses of sufficient dimensions, to be wrought into various extremely-ornamental objects, such as vases, basins, obelisks, &c. This manufacture is confined to Derbyshire, no other part of the world affording fluor sufficiently firm and tenacious for the purpose, and which is, at the same time, possessed of fine colours. The work is performed on a lathe, turned by water, the foot-lathe being much more liable to produce fractures in the piece worked, by its want of steadiness. The tool employed, at first, is a piece of the best steel; after which a coarse stone is applied, with water, so long as the smoothness is improved by these means; then the finer gritstone, pumice, &c.; till, finally, the article becomes sufficiently smooth to receive emery, with which the operation is completed.

FLUORIC ACID, is prepared by mixing pure fluor-spar, in coarse powder, with twice its weight of sulphuric acid, in a leaden or silver retort, and applying heat. The acid distils over in vapour, and must be collected in a receiver of the same metal, surrounded by ice.

At the temperature of 32° Fahrenheit, fluoric acid is a colourless fluid, and remains in that state at 59°, if preserved in well-stopped bottles; but, when exposed to the air, it flies off in dense white fumes, which consist of the acid in combination with the moisture of the atmosphere. Its sp. gr. is 1·0609; but its density may be increased, by gradual additions of water, to 1·25.

Its affinity for water is far greater than that of the strongest sulphuric acid. When a drop of it falls into water, a hissing noise is heard, similar to what is occasioned by plunging a red-hot iron into that liquid. Its odour is extremely penetrating, and its vapour dangerous to inspire. When applied to the skin, it instantly disorganizes it, and produces the most painful wounds. It acts energetically on glass; the transparency of the glass is instantly destroyed, caloric is evolved, and the acid boils, and, in a short time, disappears entirely, a colourless gas being the sole product. This gas has received the name of *fluo-silicic acid*, because it is regarded as a compound of fluoric acid and silica. It is about 48 times denser than hydrogen. When brought into contact with water, it is instantly absorbed, depositing its silica in a white gelatinous mass, which is a hydrate of silica. It produces white fumes, when suffered to pass into the atmosphere. From the strong affinity of fluoric acid for silica, it cannot be preserved in glass bottles; and is, therefore, kept in vessels of lead or silver. For the same reason, fluoric acid is employed for etching on glass—its only important application.

Fluoric acid forms salts, by uniting with several bases. Five fluates have hitherto been found native; viz. the fluate of lime, or fluor-spar, the fluosilicate of alumine, or topaz, the fluate of cerium, the double fluate of cerium and yttria, and the double fluate of soda and alumine, or cryolite. The four latter are very rare minerals, but the first is abundant.

FLUORINE, is a factitious product of chemistry, which theory places by the side of oxygen. It is a product of fluor spar and the basis of the corrosive fluoric acid.

FLUX, is a general term, to denote any substance or mixture added to assist the fusion of minerals.

In the large way, limestone and fluor-spar are used as fluxes.

The fluxes made use of in assays, or philosophical experiments, consist usually of alkalies, which render the earthy mixtures fusible by converting them into glass. Alkaline fluxes are either the crude flux, the white flux, or the black flux. Crude flux is a mixture of nitre and tartar, which is put into the crucible with the mineral intended to be fused. The detonation of the nitre with the inflammable matter of the tartar is of service in some operations, though generally it is attended with inconvenience, on account of the swelling of the materials, which may throw them out of the vessel.

White flux is formed, by projecting equal parts of a mixture of nitre and tartar, by moderate portions at a time, into an ignited crucible. In the detonation which ensues, the nitric acid is decomposed, and flies off with the tartaric acid; and the remainder consists of the potash, in a state of considerable purity. This has been called fixed nitre.

Black flux differs from the preceding in the proportion of its ingredients. In this, the weight of the tartar is double that of the nitre, on which account the combustion is incomplete, and a considerable portion of the tartaric acid is decomposed by the mere heat, and leaves a quantity of coal behind, on which the black colour depends. It is used where metallic ores are intended to be reduced, and effects this purpose by combining with the oxygen of the oxide.

The following FLUXES are employed, for the purposes specified, in the manufacture of earthenware and porcelain.

Take 32 parts of silica, (the *dry flint* of potters) 4 parts of carbonate of potash, 5 parts of borax, and 4 parts of white oxide of lead; fuse well in air furnace, and afterwards let it be carefully picked, pulverized, and sifted. This flux is useful for various purposes, in colours.

*Red Flux.* Fuse as above, and treat similarly 12 parts of flint glass, 5 parts of red oxide of lead, and 1 of borax.

*White Flux.* Treat, as above, 6 parts white oxide of lead, 4 parts of borax, and 2 parts of silica.

*Purple Flux.* 7 parts red oxide of lead, 2 silica, and 10 borax; treated as above directed.

*Rose-Colour Flux.* 28 parts silica, 24 parts borax, 20 parts red oxide of lead, and one of cullet, (broken glass.)

Flux for *Red or Purple Brown.* 18 parts red oxide of lead, 12 parts borax, 6 parts silica, and 3 parts cullet.

*White Dry Flux.* 4 parts silica, 2 parts borax, and 2 parts white oxide of lead.

*Lead Flux.* 3 parts white oxide of lead, 1 of silica.

*Flux for Printing Blue.* 1st, 10 parts silica, 3 parts borate of soda, 1 part nitrate of potash: 2d, 5 silica, 6 cullet, 1 borate of soda, 1 nitrate of potash; 3d, 4 silica, 1 cullet, 1 of fritt No. 3, for porcelain glazes. (*See* FRITT.)

FLUX, *white*, is tartrate of potash, or cream of tartar and nitre, in equal quantities, detonated in a red-hot crucible.

FLUX, *black*, is tartrate of potash, with half nitre detonated in a red-hot crucible.

FLUX, *raw*, is tartrate of potash, mixed with nitre, in any proportion.

Fluxes, are substances added to metals in furnaces, to facilitate their fusion, by converting their earths into glass, and, therefore, are alkaline, as lime-stone, in iron-stone furnaces. In small experiments, nitre and tartar are gradually introduced. Alone, they form potash or fixed nitre. Black flux is 2 tartar to 1 of nitre, and it reduces oxides. Another flux is 16 powdered glass without lead, 2 of calcined borax, and 1 of charcoal.

FLY, is a name given to an appendage to many machines, either as a regulator of their motions, or as a collector of power. When used as a regulator, the fly is commonly a heavy disk, or hoop, balanced on its axis of motion, and at right angles to it; though sometimes a regulating fly consists of vanes or wings, which, as they are whirled round, meet with considerable resistance from the air, and thus soon prevent acceleration in the motion; but this kind of regulator should rarely, if ever, be introduced in a working machine, as it wastes much of the moving force. When the fly is used as a collector of power, it is frequently seen in the form of heavy knobs at the opposite ends of a straight bar, as in the coining-press, steam-engine, &c.

In most machines, the irregular moving power is directed to the fly-wheel, and the uniform velocity of this assures regular motion to the machinery; or, if the resistance, or work, is irregular, as in the pile-engine, in threshing, grinding, &c. the fly receives an equal force of power. It also adjusts the varied force with which a man turns a winch, with which horses work, &c.

FOCUS, in optics, is a point wherein the several rays are collected, after having undergone refraction or reflection. But the focus is not strictly a point; for the rays are not accurately collected into the same point, owing to the different refrangibility of the rays of light to the oblique surface of the lens. The focus, therefore, is a small circle, which is, at least, one-eighth the thickness of the lens, when convex on both sides.

FOG.—The constant ascent of watery particles from the surface of the earth, occasioned by the heat of masses of water and moist bodies; and part of the water which rises in vapour, is intimately united with the atmospheric air in solution. This aqueous matter is invisible, and exists in the greatest quantity in warm weather. Thus, in the hot days of summer, any cold body is immediately covered with little globules of water, which are the vapour of the atmosphere precipitated. But when the air is saturated, the watery particles which continue to rise are no longer dissolved, but remain suspended in vapours, which form clouds when they rise to a great height, and fogs when they hover near the surface of the earth.

FOIL, is a thin leaf of metal, placed under transparent substances, for improving their colour, and heightening their lustre, the light which passes through the transparent body being reflected by the metal. *Foil* is also used to signify the sheet of amalgam laid on the back-side of a mirror, which enables it to reflect a complete image.

FOMENTATION, is the external application of a fluid, as warm as the patient can bear it, by two flannel cloths dipped in the liquor, or solution.

FOOT-ROT.—Caustics have been usually resorted to for the cure of this disease, and the substances employed have been various. The following composition, Mr. W. Hogg has found to be the speediest, the most powerful, and by far the mildest. To make one gill; to two ounces of turpentine put half an ounce of diluted vitriol; stir the residuum of the turpentine from the bottom before using. Pare away what of the hoof is loosened from the foot, then anoint it with the above composition. Beware of cutting, or otherwise bruising, the sensible part of the foot; for this encourages the growth of fungous granulations, which are often very difficult to be destroyed. If the weather be dry, and the operation properly conducted, two or three dressings with this mixture are usually sufficient to remove the disease.

FORCE, in mechanics, denotes that combination of matter and motion which produces a change in the state or position of a body. According to this definition, the muscular power of animals, as likewise pressure, impact, gravity, &c. are considered as effects of motion in other bodies; it being evident, from daily experience, that bodies exposed to any free action have force imparted to them, or are themselves thereby imbued with power. All forces, however various, are measured by the effects which they produce in like circumstances, whether the effect be creating, accelerating, retarding, or deflecting motions.

When we say that a force is represented by a right line, A B, it is to be understood that it would cause a material body, situated at A, to run over the line A B, which is called the direction of the force, so as to arrive at B at the end of a given time, while another force would cause the same body to have moved a greater or less distance from A in the same time.

The force of a body in motion is a power residing in that body, so long as it continues its motion; by means of which, it is able to move other bodies lying in its way, or to lessen, destroy, or overcome the force of any other moving body, which meets it in an opposite direction; or, to surmount the largest dead pressure or resistance.

FORCE is quantity by velocity, before or after impact; and if quantity is increased, velocity is diminished. Nature and art is a display of the transfer and reception of force, *ad infinitum*, and what is lost by one body, is gained by other bodies, by these transferred again, and sometimes collected or concentrated, and at other times scattered and diffused. To trace the sources and distribution, is to analyse nature; but it is the most general of all laws, that wherever there is force, there is some matter, in some fit motion; and wherever there is matter in motion, there is resulting force.

Of course, there are no innate, or miraculous forces—no attraction—no repulsion—no elastic force—no vital force —all are derived from previous motions in other bodies, and the phenomena depend on the quantities of the agents and patients, on the direction of their velocity, and on various reactions.

Composition of forces takes place when two or more forces, differently directed, act upon the same body at the same time. As the body then cannot obey them all, it will move in a direction somewhere between their line. This is called the *composition* and *resolution* of forces or of motion. But, if the body be impelled by equal forces, acting at right angles to each other, it will move in the diagonal of a square, and instances in nature, of motion produced by several powers acting at the same time, are innumerable.

All machines are impelled either by the exertion of animal force, or by the application of other powers of nature. The latter comprise the elements of water, air, and fire. The former is more common, yet so variable as hardly to admit of calculation. It is derived from the muscular lever of the animal acting against the ground, and the power of the muscles to act is derived from the gas fixed by respiration. It depends not only on the vigour of the individual, but on the different strength of the particular muscles employed. Every animal exertion is attended by fatigue of the muscles; it soon relaxes, and would speedily produce exhaustion. The most profitable mode of applying the labour of animals is to vary their muscular action, and revive its tone by short and frequent intervals of repose. The ordinary method of computing the effects of human labour is, from the weight which it is capable of elevating to a certain height, in a given time, the product of these three numbers expressing the absolute quantity of performance. This was reckoned by Bernoulli and Desaguliers, at 2,000,000 lbs. avoirdupois, which a man could raise one foot in a day. But, our civil engineers have gone much further, and are accustomed, in their calculations, to assume that a labourer will lift 10 lbs. to the height of 10 ft. every second, and is able to continue such exertion for 10 hours each day, thus accumulating the performance of 3,600,000 lbs. one foot.

Coulomb has furnished the most accurate and varied observations on the measure of human labour. A man will climb a stair, from 70 to 100 ft. high, at the rate of 45 ft. in a minute. Reckoning his weight at 155 lbs., the animal exertion for one minute is 6975, and would amount to 4,185,000, if continued for 10 hours. A person may clamber up a rock 500 ft. high, by a ladder-stair, in

20 minutes, and, consequently, at the rate of 25 ft. each minute; his efforts are thus already impaired, and the performance reaches only 3875 in a minute. But, under the incumbrance of a load, the quantity of action is still more remarkably diminished. A porter, weighing 140 lbs., was found willing to climb a stair, 40 ft. high, 266 times in a day: but he could carry up only 66 loads of firewood, each of them 163 lbs. weight. In the former case, his daily performance was very nearly 1,500,000; while, in the latter, it amounted only to 808,000.

The quantity of permanent effect was hence only about 700,000, or scarcely half the labour exerted in mere climbing. In the driving of piles, a load of 42 lbs., called the *ram*, is drawn up $3\frac{1}{2}$ ft. high 20 times in a minute; but the work has been considered so fatiguing, as to endure only three hours a day. This gives about 530,000 for the daily performance. Nearly the same result is obtained, by computing the quantity of water, which, by means of a double bucket, a man drew up from a well. He lifted 36 lbs. 120 times in a day, from a depth of 120 ft., the total effect being 518,400. A skilful labourer, working in a field with a large hoe, creates an effect equal to 728,000. When the agency of a winch is employed in turning a machine, the performance is still greater, amounting to 845,000. In all these instances, a certain weight is heaved up, but a much smaller effort is sufficient to transport a load horizontally.

A man could, in the space of a day, scarcely reach an altitude of two miles, by climbing a stair; though he will easily walk over 30 miles, on a smooth and level road. But he would, in the same time, carry 130 lbs. only to the fourth part of that distance, or $7\frac{1}{2}$ miles. Assuming his own weight to be 140 lbs., the quantity of horizontal action would amount to 42,768,000, or 28 times the vertical performance; but the share of it, in conveying the load, is 20,961,780, or about 30 times what was spent in its elevation. The greatest advantage is obtained by reducing the burden to 102 lbs., the length of journey being augmented in a higher ratio.

According to some experiments of the late Mr. Buchanan, the exertions of a man in working a pump, in turning a winch, in ringing a bell, and in rowing a boat, are as the numbers 100, 167, 227, and 248.

A man's force, in fact, is such, that he can raise 10 lbs. 10 ft. in a second, for 10 hours in a day, or 100 lbs., or 10 imperial gallons one ft. per second, or in 10 hours, (36,000 seconds) 3,600,000 lbs. one ft., or 360,000 gallons one foot.

The labour of a *horse* in a day is commonly reckoned equal to that of five men; but then he works only eight hours, while a man easily continues his exertions for ten hours. Horses, likewise, display much greater force in carrying than in pulling; and yet an active walker will beat them on a long journey. Their power of drawing seldom exceeds 144 lbs., but they are capable of carrying more than six times as much weight. The pack-horses in the West Riding of Yorkshire are accustomed to transport loads of 420 lbs. over a hilly country. But, in many parts of England, the mill-horses will carry the enormous burden of 910 lbs. to a short distance. With regard, however, to the ordinary power of draught, the formula $(12-v)^2$, where $v$ denotes the velocity in miles an hour, will perhaps be found sufficiently near the truth. Thus, a horse beginning his pull with the force of 144 lbs., would draw 100 lbs. at a walk of two miles an hour, but only 64 lbs. when advancing at double that rate, and not more than 36 lbs. if he quickened his pace to six miles an hour. His greatest performance would hence be made with the velocity of four miles an hour. The accumulated effort in a minute will then amount to 22,528. The measure generally adopted for computing the power of steam-engines is much higher, the labour of a horse being reckoned sufficient to raise, every minute, to the elevation of one foot, the weight of 32,000 lbs. Wheel-carriages enable horses, on level roads, to draw, at an average, loads about 15 times greater than the power exerted.

The patient drudgery of the ass renders him a serviceable companion of the poor. Much inferior in strength to the horse, he is maintained at far less cost. An ass will carry about 2 cwt. of coals, or lime-stone, 20 miles a day. But, in warmer climates, he becomes a larger and finer animal, and trots or ambles briskly under a load of 150 lbs.

The *mule* is still more powerful and hardy, being fitted equally for burden and draught.

In the hotter parts of Asia and Africa, the ponderous strength of the *elephant* has been long turned to the purposes of war. He is reckoned more powerful than six horses, but his consumption of food is proportionally great. The elephant carries a load of 3 or 4000 lbs.; his ordinary pace is equal to that of a slow trot; he travels easily over 40 or 50 miles in a day, and has been known to perform, in that time, a journey of 110 miles. His sagacity directs him to apply his strength according to the exigency of the occasion.

The *camel* is a most useful beast of burden in the arid plains of Arabia. The stronger ones carry a load of 10 or 12 cwt., and the weaker ones transport

6 or 7 cwt.; they walk at the rate of two miles and a half in an hour, and march about thirty miles every day. The camel travels often eight or nine days, without any fresh supply of water. When a caravan encamps in the evening, he is, perhaps, turned loose, for the space of an hour, to browze on the coarsest herbage, which serves him to ruminate during the rest of the night. In this manner, without making any other halt, he will perform a dreary and monotonous journey of 2000 miles.

Within the arctic circle, the *rein-deer* is a domesticated animal, not less valuable. He not only feeds and clothes the poor Laplander, but transports his master, with great swiftness, in a covered sledge, over the snowy and frozen tracts. The rein-deer subsist on the scanty vegetation of moss or lichens, and are docile, but not powerful. Two of them are required to draw a light sledge: so harnessed, they will run 50 or 60 miles on a stretch, and sometimes perform a journey of 112 miles in the course of a day. But such exertions soon wear them out.

All animal power is obviously derived from the *motions* of the gas inspired and fixed by and in the lungs. Hence, the rapid and large inspirations during bodily exertions, and the degrees of strength proportioned to size of lungs.

FORCING, among gardeners, or making trees produce ripe fruit before their usual time, is done by planting them in a hot-bed, against a south wall, and likewise defending them from the injuries of the weather, by glass frames. They should always be grown trees, as young ones are apt to be destroyed by this management, and the glasses must be taken off at proper seasons, to admit the benefit of fresh air, and especially of gentle showers.

FORE-SHORTENING, in drawing and painting, is the art of representing figures of all sorts, as they appear to the eye, in oblique positions. This art, in many instances, is very difficult. Among the moderns, Correggio must be allowed the palm for excellence in fore-shortening. It is acquired by studying the best masters.

FORMATION, GEOLOGICAL, is a distinct mineral bed or stratum, differing essentially from that lying *beneath*, and that *above*, both in aspect, mineral constituents, and fossil contents.

In most formations, there are some mineral and fossil affinities; and in many, even where the external differences are apparently complete, there are some common characters, by the aid of which a transition from one to the other can be traced.

Chalk differs essentially, both from the green sand which lies beneath it, and the plastic clay which lies above it, in its aspect, its mineral constituents, and many of its fossil contents; yet the green sand passes into the chalk marl, and this last into the chalk; and their common characters are almost obvious enough to warrant our classing all the beds of chalk and green sand in one formation, did not the cretaceous and flinty characters of the first distinguish it from all the rest.

By *formation*, also, is meant a whole assemblage of beds, distinct from each other, but lying in *a group*, in a determinate order, the whole having a common character or affinity, and being constantly found in a particular part of the geological series, overlying some other formation distinct from itself.

The *oolitic series* is an assemblage of this kind, having a common oolitic character, from the *lias* to the *Portland oolite* inclusive, notwithstanding the important deposits of Kimmeridge clay, Oxford clay, &c. &c. which occasionally separate the calcareous beds.

The *coal formation* is another series of alternate beds of coal, slate clay, sand-stone, and lime-stone, and illustrative of this kind of formation. Coal, it is true, is occasionally found in the inferior deposits of the mill-stone grit, the carboniferous lime-stone, &c. and under circumstances that might warrant our classing them all in one group, as has been done with the oolitic series, from the prevalence of the oolitic character; but, as fossil coal is only worked profitably in beds, above the carboniferous lime-stone, the term *coal formation* is more properly restricted, for the present, to those beds.

The unvarying succession of formations to each other, in the geological series, has been found to exist in parts of the earth widely separated from each other, and warrants, not only the belief that they have come into their order successively, but that the causes which brought each formation to its place were of one class, whether of igneous or of aqueous origin, and operated simultaneously.

Whether we consider the invariable succession, in all the observed parts of our planet, of the gneiss to the granite, the mica to the gneiss, and of the subsequent primitive limestones and slates, or the deposits of the carboniferous limestones, we cannot but look to a regular succession of causes, for the production of these uniform results. And, although the order and continuity of the series are much interrupted occasionally, it is less difficult to believe, that particular circumstances have interrupted such succession and continuity, than that such regular causes have not existed.

There can be no doubt whatever, that general physical causes, as the varied reaction of the earth to the sun, and the varied direction of those reactions as to the terrestrial hemispheres in the circuit of the line of apsides in 20930 years, is the primary cause by which the seas, in following the forces, produced the various formations in the earth's crust.

FORTUNE-TELLING.—This art is alluded to, for the purpose of guarding the reader against its illusions. It has misled mankind in all ages and countries, and of all ranks, but never the truly wise. Its credit arises from want of analysis. Any future event, and every event, is within a certain range of probability, as 2 to 1, 3 to 1, or 50, or 500 to 1. If, then, 100 events are foretold by any conventional signs, and they are not improbable, it is 2, 3, or 4 to 1, that they come true. If 2 to 1, 33 may come true; if 3 to 1, 25; and if 4 to 1, 20, and so on. Herein, then, lies the whole mystery. The astrologer, or fortune-teller, does not invent, but is governed by certain signs, as cards, planets, tea-grounds, &c. &c.; but these only guide him in announcing probability; and, because they afford the key, according to certain rules of his art, and are not his invention, the announcements, nevertheless, come equally within the range of mere arithmetical probabilities. The events are not controlled by the cards, stars, or tea-grounds; and, in truth, these are merely the passive machinery which blind both the fortune-teller and his dupe. At the same time, clever fortune-tellers never foretell improbabilities. They do not tell a boor that he will be a king, nor an old woman that she will have five or six children. They shape their prognostics to the sphere and age of the parties; and hence, if clever, raise the probabilities to the highest, as equal 1 to 2, or 1 to 3, and seldom mention circumstances 5, 10, or 20 to 1 against happening.—*Walk to Kew.*

FOTHERGILL'S PILLS, are equal quantities of aloes, scammony, colocynth, and peroxide of antimony.

FOUNT, or FONT, among printers, &c.; a set of types, sorted for use, that includes running letters, large and small capitals, single letters, double letters, points, commas, lines, numerals, &c.; as a fount of English, of Pica, of Bourgeois, &c. A fount of 100,000 characters, which is a common fount, would contain 5000 types of *a*, 3000 of *c*, 11,000 of *e*, 6000 of *i*, 3000 of *m*, and about 30 or 40 of *k*, *x*, *y*, and *z*. But this is only to be understood of the lower-case types; those of the upper-case having other proportions.

FOUNTAIN, or ARTIFICIAL FOUNTAIN, in hydraulics; a machine, or contrivance, by which water is violently spouted or darted up; called also a *jet d'eau.* There are various kinds of artificial fountains, but all formed by a pressure, of one sort or another, upon the water; viz. either the pressure or weight of a head of water, or the pressure arising from the spring and elasticity of the air, &c. When these are formed by the pressure of a head of water, or any other fluid of the same kind with the fountain, or jet, then will this spout up nearly to the same height as that head, abating only a little for the resistance of the air, with that of the adjutage, &c. in the fluid rushing through; but, when the fountain is produced by any other force than the pressure of a column of the same fluid with itself, it will rise to such a height as is nearly equal to the altitude of a column of the same fluid, whose pressure is equal to the given force that produces the fountain.

FOX-GLOVE; or DIGITALIS, a common flower of our hedges, whose fresh leaves, gathered while in flower, are a powerful sedative and diuretic. As a sedative, it is so influential on the system as to vary the pulse in any desired proportion. This is often useful when effect is sought to be given to other medicines. As a diuretic, it carries off the water in dropsies. As a soother, it is useful in mania, also in hæmorrhages, &c. By digesting the leaves in ether, filtering, evaporating, dissolving in water, filtering, mixed with oxide of lead, evaporated, and again digested in water, the alkaline principle called *digitaline*, a bitter brown paste, is obtained. The tincture is made by digesting, for 7 days, 2 oz. of dried powdered leaves in a pint of proof spirit, and filtering. The dose 1 gr. cautiously increased to 3, 4, or 6. Too large a dose may be counteracted by brandy, or laudanum. While taking it, the pulse varies with the posture of the patient.

FRANKINCENSE, is the spontaneous exudation from the spruce fir, afterwards boiled in water, dried, and strained.

FRENCH POLISH, consists of seed lac 6 oz., gum juniper 1½ oz., gum mastic 1 oz., rectified spirit of wine 32 oz.; for want of seed lac, shell lac may be employed. All the ingredients should be first reduced to a coarse powder, and then mixed with the rectified spirit of wine, in a vessel which will contain double the quantity, in order that, on being exposed to the moderate heat of a sand bath, or other moderate heat, room may be given for the expansion of the spirit without bursting the vessel. The mixture should be well shaken at least once a day, taking care, at the same time, to loosen the cork during the shaking: a few days will be sufficient to dissolve the resins.

FRENCH DECIMAL SYSTEM. The decimal system of weights, measures, and time, was introduced into France during the revolution. All measures and weights are reduced to one basis—the linear measure. This basis, called a *metre*, is the ten millionth part of one quarter of a meridian—3 feet 0 inches, 11 $\frac{44}{1000}$ lines Paris measure, or 3 feet 3 inches $\frac{371}{1000}$ English. This unit, increased or diminished in the decimal ratio, gives the other measures, which are designated by the name of the basis, with the Greek or Latin numerals prefixed. The Latin numerals express division; the Greek, multiplication. The former are—*decem*, 10; *centum*, 100; *mille*, 1000: the latter—*deca*, 10; *hecaton*, 100; *chilion*, 1000; *myria*, 10,000. The following forms, therefore, are used (the word *metre* being always understood): 1. For the division: *deci*, $\frac{1}{10}$; *centi*, $\frac{1}{100}$; *milli*, $\frac{1}{1000}$. 2. For the multiplication: *deca*, 10 times; *hecto*, 100 times; *kilo*, 1000 times; *myria*, 10,000 times. All the names which express division end in *i*; (those which express multiplication, in *a* or *o*.) Thus, *metre*, 3·28 feet; *decimetre*, ·328 feet; *decamètre*, 32·8 feet, &c. The same process is applied to all other measures; and it is only necessary to know the relation of any given unit of measure to the basis measure, in order to be able to make the necessary reductions. These units of measure are—1. Of square measure, the *are* = 100 square *metres*; 2. of solid measure, the *stere* = 1 cubic *mètre*; 3. of measures of capacity, the *litre* = 1 cubic *decimetre*; 4. of weights, the *gramme* = the weight of 1 cubic *centimètre* of distilled water.

The *Metre* is 3·28 feet, or 39,371 in.
*Are* is 1076·441 square feet.
*Litre* is 61·028 cubic inches.
*Stére* is 35·317 cubic feet.
*Gramme* 15·4441 grains troy, or 5·6481 drams avoirdupois.

In regard to money, the franc constitutes the unit. It weighs 5 *grammes* (4½ of silver, with an alloy of ½ of copper), and is divided into *decimes* and *centimes*, 10th and 100th parts.

FRENCH FILTER.—Two concentric conical vessels are formed of wood; the outer one of them stands upon its bottom as usual: and the other, or inner one, is secured in its place upon the bottom of the other by dowels and a border around it; a row of holes also being made through and around the inner vessel, just above its bottom. Sand, and sand mixed with charcoal powder, is placed within both vessels in successive layers. A wooden cover, which is pierced full of holes, receives the water to be filtered, and which falls into the inner vessel, and thus prevents the falling water from disturbing the arrangement of the first layer of sand placed within it. On this inner vessel being kept constantly filled with water to the proper height, it descends through the different layers in the inner vessel, passes through the holes in the lower end of it, and again ascends to the cock fixed in the outer vessel, through the layers of sand placed in that vessel.

FRESCO, is that kind of painting which is executed with water-colours, upon a layer of fresh plaster, from which circumstance it derives its name. As great rapidity of execution is necessary to paint before the plaster becomes dry, cartoons are used for tracing the outlines of the figures, &c. and a small picture serves as a guide for the colours, if the cartoon does not indicate them. A great knowledge of colours, and great skill in drawing, are necessary for fresco-painting, because there is no opportunity for correcting, and whatever the painter does is finished. The colours are mixed beforehand, and put on just as they are wanted; only in the dark parts a little retouching takes place. Fresco-painting is of the most durable kind. There are specimens of it extant of the time of Constantine the Great.

FRIARS' BALSAM.—In 2 lbs. of alcohol infuse gum benjamin 3 oz., 2 oz. of strained storax, 1 oz. of balsam of tolu, and ½ an oz. of socotrine aloes.

FRICTION, is parting with the motion or velocity of one body to another when in contact, partly owing to roughness of surface, and partly owing to the tendency of all bodies to fall, though 16 feet in a second, so that every motion, when oblique, is a certain angle to that constant perpendicular force, and when horizontal at right angles to it, thereby rubbing with resistance called friction. It is found by experience that a body moves with the greatest facility on a plane inclined 18° 26′ with the horizontal plane, but it is presumed that this agrees with a certain velocity.

4 feet per second is 240 per minute, or 14400, or 2·72 miles per hour.

8 feet ...... 5·44 miles per hour.
16 feet ...... 0·88 miles per hour.
32 feet ...... 21·76 miles per hour.
40 feet ...... 27·2 miles per hour.
64 feet ...... 43·4 miles per hour.

Then, at 4 feet, the effect of weight in producing friction will be as 4 to 16·49.

At 8 feet, as 8 to 17·9; at 16 feet, as 16 to 22·63; at 32 feet, as 32 to 35·78; at 40 feet, as 40 to 43·08; and, at 64 feet, as 64 to 65·97.

In this novel way of considering the subject of friction, we see the effect of velocity in neutralizing weight. Since a body moving 4 feet has above four times its force of weight to overcome; one of 8 feet, little more than twice; one of 16 feet, but 1⅝ths; of 32 feet, but ⅛th; one of 40 feet, but 1-13th; and one of 64 feet, but 1-32d to overcome.

An angle, then, of 18·26, in bringing a moving body into a direction at 3 to 10 of the line of weight, has the same effect as a velocity of 6 feet per second.

Other causes of friction are the roughnesses, spiculæ, and angles of surfaces, removeable by filling them with oil, tallow, &c. and by diminishing the extent of surface in contact. Olive-oil reduces the friction of woods one half.

In all cases, the rubbing of large surfaces against each other should be avoided; and, hence, the use of little wheels to turn with the axis of shafts called friction-wheels, by which the contact and rubbing of large breadths is avoided. Different substances, too, should work against one another, the ultimate atoms of the bodies tending to combine by their similarity of forms.

In the screw and the wedge, the friction is equal to the power. The sheaves of pullies should not press against the blocks.

It has been carefully determined, at Baltimore, that one quart of oil is sufficient for 2000 miles run of a steam-carriage, weighing 3 tons. In the Winan's waggon, the friction-wheels dip into the oil; but, being in a cast-iron case none is lost, while renewal of oil is better than the same in long work. Purified vegetable oils answer best.

Black-lead is found to destroy friction with the best effect.

Ferguson found that the quantity of friction was always proportional to the weight of the rubbing body, and not to the quantity of surface; and that it increased with an increase of velocity, but was not proportional to the augmentation of celerity. He found, also, that the friction of smooth soft wood, moving upon smooth soft wood, was equal to one-third of the weight; of rough wood upon rough wood, one-half of the weight; of soft wood upon hard, or hard upon soft, one-fifth of the weight; of polished steel upon polished steel or pewter, one quarter of the weight; of polished steel upon copper, one-fifth; and of polished steel upon brass, one-sixth of the weight. Coulomb brought to light many new and striking phenomena, and confirmed others, which were previously but partially established.

1. The friction of homogeneous bodies, or bodies of the same kind, moving upon each other, is generally supposed to be greater than that of heterogeneous bodies; but he showed that there are exceptions to this rule.

2. It was generally supposed, that, in the case of wood, the friction is greatest when the bodies are drawn contrary to the course of their fibres; but, he showed that the friction, in this case, is sometimes the smallest.

3. The longer the rubbing surfaces remain in contact, the greater is their friction.

4. Friction is, in general, proportional to the force with which the rubbing surfaces are pressed together, and is commonly equal to between one-half and one-quarter of that force.

5. Friction is not generally increased, by augmenting the rubbing surfaces.

6. Friction is not increased by an increase of velocity; at least, it is not generally so; and, in some cases, even decreases with an increase of celerity.

7. The friction of cylinders, rolling upon a horizontal plane, is in the direct ratio of their weights, and in the inverse ratio of their diameters.

An easy method of experimenting on the friction of surfaces is, to place a plank with its upper surface level, and on this a thin block of the matter to be tried, with a cord fixed to it, which block may be loaded with different weights; and, a spring steelyard attached to the other end of the cord, to draw it along by, will show the force necessary to produce motion. It appears, from experiments, that the friction of different combinations of matter differs very considerably, and that an immense quantity of power may be lost in a machine, by using those substances for the rubbing parts which have great friction.

In a combination where gun-metal moves against steel, the same weight may be moved with a force of 15½ lbs., which it would require 22 lbs. to move when cast-iron moves against steel.

The resistance called *friction* performs important offices in nature and in works of art. Friction divides but never increases motion. Whenever a body acquires a great velocity, it soon loses it by friction against the surface of the earth; the friction of water against the surfaces it runs over soon reduces the rapid torrent to a gentle stream; the fury of the tempest is lessened by the friction of the air on the face of the earth; and the violence of the ocean is subdued by the attrition of its own waters.

Our garments owe their strength to friction; and the strength of ropes, sails, and various other things, depends on the same cause; for they are made of short fibres, pressed together by twisting; and this pressure causes a sufficient degree of friction to prevent the fibres sliding one upon another. Without friction, it would be impossible to make a rope of the fibres of hemp, or a sheet of the fibres of flax; neither could the short fibres of cotton have ever been made into such an infinite variety of forms as they have received from the hands of ingenious workmen. Wool, also, has been converted into a thousand textures for comfort or for luxury; and all these are constituted of fibres united by friction. In fine, if friction retards the motion of machines, and deflects a large quantity of moving power, we have full compensation in the numerous and important benefits which it confers.

In medicine and surgery, the act of rubbing the surface of the body, whether with the hand only, with the flesh-brush, flannel, or other substances, or with oils, ointments, or other medicinal matters, with a view to the preservation of health, or to the removal of particular diseases. The wholesome effects of friction are well illustrated by the advantages of currying horses. Friction is an efficacious remedy in several conditions of disease; particularly in chronic rheumatisms of long standing; in muscular contractions, succeeding to rheumatism, &c., and connected often with effusions of lymph; in some states of paralysis; in certain indolent tumours, &c. In these cases, a variety of unguents and liniments is recommended; *but the friction itself is the principal source of relief.*

As friction, in a great measure, depends upon the oil with which the various parts are lubricated, it is important to know that olive-oil may be freed from its mucilage by exposure to the rays of the sun for one or two years. *Or*, mix seven parts of alcohol with one of oil, and heat it in a flask almost to boiling; the lighter fluid is then decanted, and, on being suffered to cool, a solid fatty matter separates, and is removed. The alcoholic solution must then be evaporated to a fifth its bulk, and the pure oil will be deposited.

*Plumbago, instead of oil.*—That the gradual change of oil, when applied as a lubricating medium to those parts where friction takes place in clocks, watches, and other fine mechanical arrangements, has induced numerous persons to endeavour so far to purify the oil as to prevent or retard the injury occasioned to the going of the machine as much as possible. Mr. Hebert appears to have overcome this difficulty by discarding the oil altogether, and using well-prepared plumbago instead. He prepares the plumbago by repeatedly grinding and washing it over, by which means the gritty particles that occur, even in the best black lead, are removed. The prepared substance is applied with a camel-hair pencil, either in the state of powder or mixed up with a drop or two of pure spirit of wine. It readily adheres to the surface of a steel pivot, as well as to the inside of the hole in which it runs, so that the rubbing surfaces are no longer one metal upon another, but plumbago upon plumbago. These surfaces, by their mutual action, speedily acquire a polish only inferior to that of the diamond, and then the retardation of the machine from friction is reduced almost to nothing, and wear and tear from this cause is totally prevented.

The friction in screws with square threads is to that of equal screws with triangular threads as 2·90 to 4·78, proving a very important advantage of the former over the latter, relative to the loss of power incurred in both by friction.

The friction of ice rubbing upon ice diminishes with an increase of weight, but without observing any regular law of increase. When dry leather was made to move along a plate of cast-iron, the resistance is but little influenced by the extent of surface. With fibrous substances, such as cloth, the friction diminishes by an increase of pressure, but is greatly increased by the surfaces remaining for a certain time in contact: it is greater, *cæteris paribus*, with fine than with coarse cloths; the resistance is also much increased by an increase of surface. With regard to the friction of different woods against each other, great diversity and irregularity prevail in the results obtained: in general, the soft woods give more resistance than the hard woods: thus, yellow deal affords the greatest, and red teak the least friction. The friction of different metals also varies principally according to their respective hardness; the soft metals producing greater friction, under similar circumstances, than those which are hard. Within the limits of abrasion, however, the amount of friction is nearly the same in all metals.

*Soapstone* has been used for diminishing friction with great profit and success. It is first thoroughly pulverized, and then mixed with oil, tallow, lard, or tar. It is used in all kinds of machinery where it is necessary to apply any unctuous substance to diminish friction, and it is an excellent substitute for the usual composition applied to carriage vehicles.

Perkins has avoided the necessity of employing oil, grease, or any other lubricator to the piston of the steam-engine by forming his piston of bell-metal, composed of the following materials:—copper, 20 parts; tin, 5 parts; zinc, 1 part. This, as well as his cast-iron cylinder, is cast under the pressure of a considerable head of metal; by which means, the density and closeness of grain of both of them is very greatly increased, and, indeed, the cast-iron has as close a grain as wrought-iron itself! These two metals he finds to act *so as to polish each other in use.* He also uses the same dense cast-iron to form his steam-engine crank-axes, and the spindles or axes of his grindstones, &c. with; and he runs the cylindrical necks of them upon bearings formed of his bell-metal, placed underneath them, and made with hollow cylindrical cavities, across their upper faces, not exceeding the sixth part of a circle in extent; and yet, upon these very small bearings, his necks run, with a very trifling portion indeed of grease, as a lubricator. In this manner, the cylindrical necks of the axis of a large grindstone, employed in grinding large articles, run; and yet, on throwing off the band from the rigger, or band-wheel, the stone will make fifty revolutions, at least, before it stops.

FRITT, a compound substance that has been fused into a mass. In the manufacture of earthenware and porcelain, *fritts* are employed; they are compounds mechanically or chemically combined, but which, in either *body*, or *glaze*, cause a chemical action among all the materials, similarly to *fluxes* in other compounds.

The following are FRITTS adapted for porcelain bodies:—1. Take 32 parts white oxide of lead, 32 parts cullet (broken flint glass,) 96 parts silica (the dry flint of potters) 16 parts nitrate of potash, and 4 parts of borate of soda; fuse well in air-furnace 2 hours, then pulverize and sift for use.

2. *Another.*—60 parts of ground Cornish stone (the grunstein of Jamieson,) 40 parts silica, 30 parts sub-carbonate of soda, 10 parts borate of soda, and 8 parts oxide of tin; treat similarly to the preceding process.

3. *Another.*—24 parts cullet, 5 parts red oxide of lead, 1 part arsenic acid, and 1 part nitrate of potash, (as above). *Or*, with 5 parts silica also.

These are adapted for *porcelain* glazes:—

1. Take 6 parts cullet, 5 parts borate of soda, 5 parts ground Cornish stone, and 1 part nitrate of potash, (as above.)

2. *Another.*—40 parts Cornish stone, 36 parts cullet, 20 parts red oxide of lead, 20 parts silica, 15 parts carbonate of potash, 10 parts white oxide of lead, and 3 parts oxide of tin, (as above).

3. *Another.*—36 parts Cornish stone, 30 parts red oxide of lead, 20 parts silica, 20 parts borate of soda, 15 parts sub-carbonate of soda, (or for *two* last 25 parts of Abraham's boracic acid), and 5 parts oxide of tin.

4. *Another.—Or*, 4 Cornish stone, and 1 sub-carbonate of soda.

These are adapted for printed *earthenware* glazes:—

1. Take 34 parts cullet, 4 parts white oxide of lead, 2 parts muriate of soda, and 1 part nitrate of potash; also, 30 parts silica and 6 parts borate of soda. Fuse well in two crucibles in air-furnace, afterwards pick and pulverize, or grind together.

2. *Another.*—Take 34 parts cullet, 2 parts arsenic acid, 2 parts nitrate of potash, 10 parts red oxide of lead, and 1 part oxide of cobalt. *Also*, 16 parts silica, 8 parts borate of soda, 4 parts nitrate of potash, and 4 parts red oxide of lead. Fuse well in two crucibles, and treat as directed in the preceding process.

3. *Another.*—18 parts cullet, 2 red oxide of lead, 1 arsenic acid, 1 nitrate of potash, and 1-10th oxide of cobalt. *Also*, 45 cullet, 3 carbonate of potash, 6 red oxide of lead; in two crucibles, and to be treated as above.

4. *Another.*—20 parts cullet, 2 white oxide of lead, 1 muriate of soda, ½ arsenic acid, ½ oxide of cobalt, (as above.)

These are for *chalk body* glazes:—

1. Take 20 parts cullet, 6 parts silica, 4 parts nitrate of potash, 1 part borate of soda, and 1 part oxide of cobalt, (as above.)

2. *Another.*—50 parts cullet, 3 red oxide of lead, 2 carbonate of potash, 1 each of nitrate of potash, arsenic acid, and oxide of cobalt.

3. *Another.*—35 parts Cornish stone, 20 red oxide of lead, 20 borate of soda, 10 sub-carbonate of soda, 1 oxide of cobalt.

4. *Another.*—38 silica, 22 Cornish stone, 19 red oxide of lead, 11 cullet, and 1 oxide of tin.

When the Fritt is prepared, and to be used, it is mixed with the other components of the glaze, (or of the body), and the whole is ground at a mill peculiarly constructed for the purpose.—(*See* FLINT GRINDING.)

*Rose's glaze*, felspar, 50 parts; borax, 32; nitre, 6; soda, 6; Cornish clay, 6; soft, incorporates better with the colours, and renders them permanent. Grind for use.

It is said to form eight acids, from borax, silica, chromate of lead, and some oxygenous acids.

FRUIT, is the pistillum of the flower arrived at maturity. Fruit is exclusively fed by the secretions prepared for it by other parts; it is therefore affected by nearly the same circumstances as flowers. It will be large in proportion to the quantity of food the stem can supply to it: and small in proportion to the inability of the stem to nourish it. For this reason, when trees are weak, they should be allowed to bear very little. The flavour of fruit depends upon the existence of certain secretions, especially of acid and sugar; and the ripening is the conversion of acid and other substances into sugar.

The Rev. J. A. H. Grubbe has taken out a patent for a wall for fruit-trees. The intention is to erect thin partitions in gardens as substitutes for walls, against which fruit-trees may be trained, and through which the warmth of the sun may, by reason of their thinness, be transmitted, which will greatly promote the ripening of the fruit, and improve its flavour. The material proposed to be employed for constructing these walls, or partitions, is slate of the ordinary quality, in slabs of the kind usually applied to the roofing of houses. Iron frames are proposed to be prepared for the reception of the slates, like the frames of windows with holes in both sides for inserting wires to serve as trellis. These frames are to be from 6 to 8 feet wide, and of a suitable height, and may be joined together side by side, by rebates or flenges, and held fast by screws, bolts, pins, or staples, or in any way that may be found desirable to secure them firmly. Temporary blocks of stone may be placed along the ground to support the partitions, with cross pieces to receive standards or slight buttresses, to keep the wall or partition perpendicular; and against the face of the wall trellis-work of wood, or other fit material, may be placed, for the support of the branches of the trees. Walls or partitions for gardens formed in this way will transmit the heat of the sun through them; and hence fruit, which may be growing against these walls, having a northern aspect, will receive the benefit of the sun's warmth, transmitted through the slates. The patentee does not confine himself to slate, but considers that plates of iron, applied in the same way, might answer the purpose nearly as well, provided that their surfaces are blackened.

*Packing Fruit-trees.*—As soon as the tree is taken out of the ground, the roots are to be dipped in a thick mixture of earth and water. The roots are then tied in bundles, and dipped in all at once, and a mat lapped over them, to keep the earth round them together. They are afterwards placed in a box, and a piece of wood is fixed across the box, over the top part of the roots, to prevent them from moving, as the branches are not lapped up at all. Trees packed in this manner have remained in the above condition four months; and, when unpacked, the roots were throwing out new fibres.

*Fruit-tree and vine ligature.*—This process is intended to be applied in place of the annular incision which is made round fruit-trees, for the purpose of increasing the growth and the quantity of fruit. In the same place where the annular incision would otherwise be made, an iron wire is to be passed tightly round the tree two or three times, and the ends twisted together. This operation is to be performed in winter, especially in February, and before the sap is in circulation. In the summer following, after the flowering, and when the fruit begins to increase in size, the ligature is to be removed, so that the wound which may have been occasioned in the bark may cicatrize. These ligatures may be repeated every year, their places being changed, and, in place of iron wire, a hemp string well soaked in oil may be used.

In removing scions of fruit-trees stick their end into a turnip, or potatoe, and pack in moss, or hay. On arriving, half bury them in moist soil in the shade.

*Fruit-tree blossoms from frost.*—Take either young birch trees, or strong birch copse, which are of the same height as the walls, and the fuller of small spray shoots the better. The branches are trimmed off from that side of them designed to be next the wall, against which they are placed upright. One man holds them there, whilst another spreads out the branches thin, and fastens them to it with a few nails and shreds. This operation is continued along the wall till the whole is covered: any small vacancies remaining uncovered are also filled up by nailing in a few of the small branches cut off. Three pieces of rope-yarn are then run along the wall, one of them near the bottom, another along the middle, and one near the top. The rope-yarn is fastened by nails, at every 5 feet or 6 feet, to keep the birch in its place, and close to the wall. When all is finished, the small spray projects about 1 foot from the wall, affording sufficient protection to the blossom against frost during the night, and also a partial shade from the scorching sun during those clear and hot days in March and April which frequently succeed cold and frosty nights, and which do more injury during the day to peach and nectarine trees upon south walls, in low situations, than the frost during the night. The birch also prevents a current of air from passing along the surface of the wall; whereas, if canvass or other close covering be used, however closely it may be fitted to the wall at the two extremities, it always has a current of air passing between it and the wall. The birch is put up before the blossoms open, and is not removed before the latter end of May or beginning of June, according to the state of the weather. When once the birch is got ready, the walls are covered as soon as they could be with netting, and the birch is removed in less time than netting could be taken down.

FRUSTUM, is a part of some solid body separated from the rest, as the frustum of a cone is the part that remains, when the top is cut off by a plane parallel to the base.

FUCI, are a family of cryptogamic plants, inhabiting, exclusively, the ocean, and generally known by the name of *sea-weed.* The substance of these vegetables is coriaceous, membranaceous or cartilaginous, hardening when dried, and becoming sometimes brittle. They are usually fixed by one extremity to rocks, stones, &c., and rocky coasts are frequently covered with them from above low-water mark, as far as the eye can discern the bottom of the ocean. Some, however, are entirely free, and vegetate as well as those which are attached: of this kind is the *fucus natans*, which has multiplied prodigiously between the tropics, forming floating masses, that cover extensive portions of the ocean, and are so dense as to impede the course of ships, at the same time serving as a retreat for immense numbers of fish, shells, worms, and crustacea, affording an aliment to these various animals. On some parts of the coast of Europe, the *fuci* are cut several times a year, either for manure, or for burning, to obtain the soda contained in their ashes. For this latter purpose, they are dried as quickly as possible, placed in a pit five or six feet deep, containing a few sticks at the bottom, which, when the pit is filled, are set on fire, and the whole is burnt as slowly as possible without producing flame. Besides *soda*, the ashes of *fuci* contain *iodine.*

FUEL, is the pabulum of heat and flame, arising from the excitement and explosion of hydrogen, from the fuel and the simultaneous union and fixation of oxygen, whose previous motions are thereby parted with to the fuel, and both radiated in the adjacent space.

Perkins purchases the refuse, or smaller parts of gas coke, which he sifts, so as to separate the minuter parts from those of a larger size; the latter he employs as fuel in the usual manner, but the dust he mixes with 1-30th part of clay and water, and strongly compresses the mass in a cylindrical tube, out of which it falls in cylindrical pieces, more or less long. These he dries upon the top of his furnace, and they are then as capable of being burnt in it as the ordinary gas coke. By this means, he has been enabled to work a high-pressure steam-engine, alone, or without doing any work for 12 hours, at the trifling expense of 11½*d.*

*Charred peat.*—It requires 1666 lbs. of charred peat to produce the same effect as 740 lbs. of common charcoal. The charred peat, made by stifling, is superior, in its power of producing heat, to that made by distillation. Unfortunately, the stifled charred peat is a kind of pyrophorus, which takes fire if it becomes accidentally wetted, or even in moist weather.

The Dutch, who burn this fuel not only in their houses, but even in pans under their feet while they are at church in winter, are in the habit of charring it at home as it is wanted. It is first burnt in the kitchen, and when they find it is red-hot quite through, they then take it off the fire, put it in a close earthen or copper pot, and cover it down with a wet woollen or linen cloth, and, by the air being excluded, the fire is soon extinguished, and when it is cold it resembles charcoal, and will, if properly charred, burn with scarce any smoke, and very little of the suffocating quality of charcoal. Charred peat is, therefore, proper for green houses, since charcoal burnt in them is very prejudicial to the plants. The usual method of burning this peat in Holland is in cast-iron kettles, and for boiling any thing it saves half the fire it would otherwise take if burnt on a hearth, or in a grate.

In the following table, the first column gives the fraction of a pound, that will heat one cubic foot of water one degree.

The second column gives the pounds of fuel that will convert one cubic foot of water into steam.

| | *One Deg.* | *Steam.* |
|---|---|---|
| Newcastle, or caking coal | 0·0075 | 8·40 |
| Splint coal | 0·0075 | 8·40 |
| Staffordshire cherry coal | 0·0100 | 11·20 |
| Wood, dry pine | 0·0172 | 19·25 |
| —— dry beech | 0·0242 | 27·00 |
| —— dry oak | 0·0265 | 30·00 |
| Peat, of good quality | 0·0475 | 53·60 |
| Charcoal | 0·0095 | 10·60 |
| Coke | 0·0069 | 7·70 |
| Charred Peat | 0·0205 | 23·00 |

FIRE-BALLS, are of the size of goose eggs, and composed of coal and charcoal in powder, mixed up with a due proportion of wet clay, and well dried. They make a more clean, and, in all respects, a pleasanter fire than can be made with crude coals; and, it is believed, would not be more expensive fuel. In Flanders and in South Wales they are much used, particularly in making up the fire for the night.

Artificial fuel is expected to rank among modern improvements, and we have heard of an important discovery of Mr. Henry Hunt, which, it is to be regretted, he has not been encouraged to render of general service.

**FULLER'S EARTH**, a greenish grey, soft, and unctuous earth found in Surry and Buckingham, and, by containing a 4th or 5th of alumine, it removes the natural grease from woollen cloth, and absorbs grease in other ways.

**FULMINATION**, is when a substance containing nitrogen is so suddenly converted into gas as to radiate great force. It depends on the substance, not on the cause of the heat, and is no exception to the general theory of combustion. Gunpowder is its most familiar compound, consisting of nitre, sulphur, and charcoal. The common fulminating powders are made:—1. By rubbing, in a warm mortar, 3 of nitre, 2 carbonate of potash, and 1 of sulphur. Fused in a ladle, and set on fire, a little of it reports like a cannon. 2. Precipitate a solution of gold by ammonia, and a grain explodes in a spoon held over a candle. Friction also explodes this dangerous substance. 3. 100 grs. of mercury should be dissolved in a retort with $1\frac{1}{2}$ oz. of nitric acid. Pour it, when cold, on 2 oz. of alcohol, heat it till it effervesces, and collect the precipitate, which is fulminating mercury. 4. Precipitate, with lime-water, a solution of nitrate of silver. Dry the precipitate, by exposure to the air, and convert it into black powder, by pouring on it liquid ammonica. When dry, it will bear neither heat nor friction, but explodes with any motion with great violence. 5. 3 parts of chlorate of potash, and 1 of sulphur, detonate with trituration in a mortar or by blows. 6. Twice the chlorate with 1 of sulphur and 1 charcoal. 7. The chlorate with gum and alcohol detonate with a blow. 8. The most formidable and dangerous of all fulminating substance is chloride of nitrogen, made by the absorption of chlorine gas, by a solution of nitrate of ammonia. 9. Iodine of nitrogen, or iodine in powder, mixed with a solution of ammonia in water. 10. Ammoniacal gas, mixed with oxygen or chlorine, form detonating compounds.

Fulminating powder is a mixture of 2 parts nitre, 2 parts neutral carbonate of potash, 1 part of sulphur, and 6 parts of common salt, all finely pulverized.

**FUMIGATION**, for a sick chamber, is effected by pouring vinegar on a hot shovel; or by mixing equal parts of nitre and sulphuric acid, in a tea-cup, and stirring it with a tobacco-pipe.

The best fumigation for sick chambers, while the patient is in them, is to pour two fluid drs. of sulphuric acid on four drs. of powdered nitre in a tea-cup. This is brief and simple, and will purify 700 cubit feet of air.

The oxygen of manganese is the basis of effective fumigation. 3 oz. of the black oxide, and $4\frac{1}{2}$ of common salt must be mixed as powder, and then 12 oz. of sulphuric, and 6 oz. of water mixed, cooled, and poured over the powders. This generates the highly-concentrated oxygen gas, called oxy-muriate acid gas, or chlorine gas. All metallic substances should be removed and the room closed for two or three hours, but a free current of air passed before the room is entered.

Cloths dipped in a solution of the oxy-muriate of lime, often called chloride of lime, absorbs putrid or infectious vapour in an apartment as effectually as sprinkling.

*Disinfecting Liquor*, is carbonate of soda, saturated with chlorine, or oxy-muriatic gas.

Dr. Henry has made a series of experiments on the disinfecting powers of increased temperatures. The object, in this instance, was to place articles of clothing, &c. which are intended to be *disinfected*, in a steady temperature, above 200° Fahrenheit, for any required length of time, without however allowing the steam, which produces the heat, to come in contact with the substances so exposed.

The dimensions and shape of the apparatus may be varied according to the extent of the operations for which it is intended. For domestic purposes, a common tea-kettle, by stopping the spout with a plug, and making additions to the lid, will answer perfectly well; and a cheap and simple disinfecting vessel may easily be contrived. For large operations, a boiler of sheet iron, resembling a steam-engine, will be necessary. If heated air should be found adequate to the effect, it might be employed for ordinary articles, reserving the more costly vehicle, steam, for articles which are of great value, and which are easily injured. Some diseases, as cholera, are not obstructed by the known disinfectants.

**FUMIGATING PASTILES**, must have only those components which are fragrant when burned; hence, musk and civet are worse than useless, In mucilage of gum tragacanth mix 2 oz. of benjamin, 1 dr. of cascarilla, half a dr. of myrhh, 15 drops each of oils of cloves and nutmegs, 1 dr. of nitre, and $1\frac{1}{2}$ oz. of charcoal; or, 36 oz. of charcoal, 8 oz. of benjamin, 12 drs. of storax, and $1\frac{1}{2}$ drs. each cloves, mastich, labdanum, and frankincense, in mucilage of gum tragacanth.

FUNNELS, for culinary purposes, are made of tin, but, for the laboratory, of glass or Wedgewood ware. When paper filters are used, the sides should be fluted. When other filters are necessary, broken glass, or fine sand, may be placed near the bottom. To separate liquids, of different density, they may be put into a long funnel stopt at the bottom, left to stand, and separate into strata, and the densest drawn off at the bottom.

FUNGI, prove frequently poisonous. The best remedy, after vomiting, by tickling the fauces, and the exhibition of clysters, is ether one dr. in a glass of water, with tincture of capsicum. The Russians eat most species of any size, stewing them thoroughly, and diluting with a glass of brandy. The chief are: —*Morells*, wholesome and agreeable. They are principally imported dry from Italy, and used as a sauce. *Truffles*, are used as delicate sauces to soups. They grow under-ground, and are turned up, or pointed out by hogs, or trained dogs. They are imported from France and Italy, either dry, or preserved in olive-oil. *Puff balls*, are narcotic; the smoke stupifies bees, without killing them; the subtile seminal dust is styptic. *Boletus suaveolens*, is used in phthisis; one scruple, in powder, four times a day, in an electuary. *Agaric of the Tartary larch*, (*Male agaric.*) A fungus, of which the interior part is friable, light, and drastic, as a purge; the dose 1 to 2 drs. in powder, with some ginger; *Or*, double infusion of. It is imported from Turkey.

*Touchwood*, *Spunk*, *German tinder*, *amadou*; is a fungus, which, softened by beating, is used to stop blood; and used as tinder, when soaked in saltpetre, and dried.

*Champignon*, or *Scotch bonnets*, is a fungus, dried, to flavour sauces. *Jews ear*, a fungus which grows on the elder; it is used in quinsey, &c. when soaked in milk or vinegar. *Oak leather*; (*Xylostroma giganteum.*) A fungus, found in the cracks of oaks, is used in Ireland to dress ulcers, and in Virginia to spread plaisters upon.

FUNGIC ACID, is the product of various fungi.

FURNACES bear various names, according to their purpose. The object of all is to procure great heat, directly applicable to the purpose.

*Iron Furnaces* consist of a cone 20 or 30 feet deep, to receive the ore, the flux, and the coke, or fuel in layers, with an ash grate beneath, and blasting bellows to increase the supply of oxygen. They are many weeks in preparation, so as to acquire a high degree of heat, and then they are never suffered to cool, but constantly supplied with ore, flux, and fuel.

A *gas furnace* is so built that the fire and flame surround the retorts full of coal, and keep them at a white heat.

A *chemical furnace* is more various in its uses, and should be built with a table-top, and horizontal flue covered with plate iron, over which should be sand baths, and other receptacles, with hoods and covers.

The *air-furnace*, for melting, has an ashes hole, and a lateral hole near the bottom of the grate. The fire-place is enclosed, and fuel put in at the top, so as to surround the covered crucibles or cucubets placed in the fire. The exit of smoke, &c. is at the side, in a horizontal flue.

A *reverberatory furnace* is one closed at the top, or with a reverberating dome with a fire beneath, and a perpendicular flue through the dome. At the side is an orifice for the neck of any retort placed in the body.

There are various patent and special varieties of furnaces, but the same general forms pervade them. Charcoal, or coke, or ashes, produce the highest heat, but coals are used in glass-houses, distilleries, and breweries.

*Accum's Lamp Furnace* is very convenient and powerful for operations in the small way. In the burning part it is Argand's lamp, but, on the upright standard, three or four arms slide with rings at their ends, to raise higher and lower, and fix with nuts and screws, adapted to receive retorts, alembics, flasks, &c. for distillations, digestions, &c. In some, a second cylinder and second flame is made, by which the heat is trebled, and most processes performed in a small way, without a furnace.

The furnace of the *Royal Institution* is of brick-work, 52 inches by 30. The iron plate and sand-baths, 57 by 42. It is 34 inches high.

A very powerful furnace, equal to any purpose, has been made at the Royal Institution, by cutting the bottom off a blue pot, and fixing it tight in a larger one, 18 by 13 inches; then, through a single hole in the bottom of the outer pot, blowing with a pair of double bellows. It melts pure iron in a quarter of an hour, renders platinum soft, and fuses rhodium. The fuel is coke, and it disappears, leaving scarcely slag; proving the superiority of the blast furnace over all others.

Farady states, that a pint of water may be boiled in a cartridge-paper vessel, placed over a chemical lamp.

Mr. Nott has taken out a patent for a mode of giving to furnaces a circular or semicircular form, that the fresh coals, when the fire receives a supply of them, may be, by turning the furnaces on pivots, by which it is supported, brought into a position with reference to the coals already ignited, that the gaseous products of the fresh coals shall pass through the ignited portion, that the combustible part may be consumed; and thus effect a saving of fuel, and the prevention of much of the nuisance arising from the escape of unconsumed smoke. This rotating, or rather vibrating furnace, is of course to be provided with an iron casing, to surround the sides of the furnace not intended to be exposed.

By Witty's improved furnace, fresh coal is first carbonised, that is, the gas is separated from it and inflamed, leaving only coke, which, being slowly pushed forward, supplies the coke fire; and the combustion or burning of the coke produces heat enough to carbonise the coal, and air enough to inflame the gas; consequently, coal, instead of being burned in its usual crude state, is subjected to two distinct processes, viz. carbonisation, and then combustion; for by this contrivance he burns the gas and the coke together.

The vent of a furnace has given rise to much difference of opinion as to the size it ought to have. Some make it large, to allow a freer passage for the burnt air into the chimney; others again, small, that the heat may not be dissipated and carried up into the chimney in waste. It is generally a single opening, but, in porcelain furnaces, the manufacturers use a number of small openings, instead of a single vent, with the view of assisting in the equal distribution of the heat throughout all parts of the chamber: and this practice should be adopted whenever this equal distribution is requisite. These artists are also careful that the sum of the areas of these holes should be exactly equal to that of the throats by which the flame and heated air enters into the chamber. It seems, therefore, advisable, in all cases, to make the vent or vents equal in area to that of the free space left between the bars of the grate. Mr. Losh proposed to remove the vent to the front of the furnace, immediately over the feeding or stoking-door, and to conduct the burned air, through channels made in the masonry, into the flue of the chimney. A great advantage attends this construction, that, when either of the entrances into the fire-room are opened, the indraught of air, instead of rushing over the surface of the burning fuel, and striking against the vessels and materials, instantly passes up the vent, and does not enter at all into the interior of the furnace, whence this is much less cooled than in the furnaces of the usual construction.

The chimney, or flue, is one of the most important parts of a furnace; and yet, in general, the least attended unto; being usually made much too large in its horizontal area. By making it thus large, the draught through it is much diminished, and the soot collects and becomes troublesome. For, when the sides of the flue contain a larger surface than can be duly heated, the necessary rarefaction of the air passing through it is destroyed. On this principle, alone, the draught of chimneys depends; and the cavity being too large proportionably to the current of air, the force of it is so diminished that the soot, instead of being blown out, gathers and rests on the sides till it obstructs the passage, and choking up the draught deadens the fire, especially at the first lighting of it, by which means the progress of the operation is sometime greatly retarded. Instead, therefore, of the large proportion now made use of, if the chimney be intended for the use of one furnace only, an area equal to that of the free space between the bars of the grate is fully sufficient; and this may be increased in proportion, where it is designed for a greater number.

The calculations of Tredgold show that each side of a chimney having a square basis, or the narrowest side, if the basis be rectangular, should be, at the least, one foot in breadth for every 10 feet in height; and the area of the flue ought not to exceed one-third of the area of the chimney.

The wall of chimneys is usually single, but when the air which passes up the flue is very hot, it has been found preferable to have the wall double, with an empty space left between the two, which are tied together from space to space, by bricks passing from one to the other.

FURNITURE BALLS.—In 1 pint of linseed-oil, by a gentle heat, mix together 2 oz. of yellow rosin, 18 oz. of bees' wax, and 2 oz. of borage root.

FURNITURE CREAM.—In a little water dissolve 1 oz. of pearl-ash, and by heat dissolve 2½ oz. of white wax; then add water, in the whole, 1 quart. *Or*, boil together, in soft water, 5 pints, 2 oz. of soap, ½ lb. of bees'-wax, and 1 oz. of pearl-ash. *To varnish wood.*—The former is used diluted with water, laid on with a fine brush, and afterwards polished with a hard brush and a cloth.

FURNITURE OIL, *(Mahogany stain.)* Mix 1 gall. of linseed-oil, 12 oz. of alkanet-root, and 2 oz. of rose-pink. *Common.* In 1¼ lbs. of linseed-oil boil 4 oz. of rosin.

FUR OF RABBITS.—One fur, and one only, is peculiar to England, namely, the silver-tipped rabbit of Lincolnshire. This fur is a dark or lighter gray, mixed with longer hairs tipped with white.

It is little used in this country, but is readily purchased abroad, especially in Russia and China. In assorting it for these markets, it is, however, necessary to be careful with respect to the colour, for while the Russian will eagerly purchase the dark-coloured skins, he makes no account of the gray ones. The Chinese are equally fastidious, but their taste happens to be the reverse of the Russians.

FUSE FOR MINERS.—Mr. John Hancock, now of Truro, has invented a composition which burns under water, and, of course, in all the damp of mines and their plugs, for blasting. It is cheap, and made in rods, for use, of all lengths. He can, too, so vary its inflammability that a yard may burn out in any desired time. We are not at liberty to describe its composition, but we have witnessed its effects when immersed in water, and they are as precise as in air. It must be regarded, in many senses, as a very important discovery.

FUSIBLE METAL, consists of bismuth 2 oz., lead 5 oz., tin 3 oz., melted together. This alloy melts in boiling water, and is used to write on asses' skin, or paper prepared by rubbing burnt hartshorn into it, and also for toys.

ONION'S FUSIBLE METAL.—Lead 3 oz., tin 2 oz., bismuth 5 oz.; melts at 197° Fahrenheit.

FUSION POWDER, is 8 of nitre, 1 of sulphur, and one of fine saw-dust. Wrapt in copper, and thus enclosed, it explodes, and melts the copper into a sphere.

FUSION, is performed in iron or earthen pots, or in crucibles of pure clay, or black-lead, or in those called Wedgwood's and Hessian. Mere liquifaction of unctuous bodies may be performed in any vessel, but, fusion of metals, &c. requires great heat. These do not melt gradually; but, as conductors of heat, are equally affected through, and melt at once and altogether. Nitre must not be put into black-lead crucibles, nor salts or acids into iron ones; silver and platinum are best when they can be afforded. Glass answers for the lamp.

FUSTIC, is wood of a yellow colour, containing great quantities of colouring matter, and forming the most durable of the yellow dyes; but is mostly used in compounding green, and drab, and olive colours, since, when employed alone, it is deficient in clearness. It is the product of a tree allied to the mulberry, in the West Indies and Campeachy. It also grows West of the Mississippi; and, being remarkably firm, solid, and elastic, is highly prized by the Indians for making their bows, and called Osage orange or bow-wood. It attains the height of 60 feet in the West Indies, but in Louisiana is only 25 or 30. The fruit resembles a large orange, in external appearance, and consists of woody fibres, radiating from the centre.

GALL-BLADDER, (The) is usually of the shape of a pear, and the size of a small hen's egg. It is situated on the concave side of the liver, and lies upon the colon, part of which it tinges with its own colour. It is composed of four membranes, or coats—the common, the vesicular, the muscular, and the nervous one, which last is of a wrinkled or reticulated surface within, and furnished with an unctuous liquor. The use of the gall-bladder is to collect the *bile* secreted in the liver, and, mixing with it its own peculiar produce, to perfect it further, to retain it a certain time, and then to expel it.

The gall, bile, and bilious system, are to be regarded as the results of the secretions of the nitrogen of the air by the skin. The oxygen is fixed and secreted by the lungs, and the nitrogen simultaneously by the skin; the one sustaining the arterial circulation, and the other the venous. Their action and reaction is healthy animal life. Any disturbance is disease, and the arrestation of either is death.

GALL, denotes any protuberance or tumour produced by the puncture of insects on plants and trees of different kinds. Galls are of various forms and sizes, and no less different with regard to their internal structure. Some have only one cavity, and others a number of small cells communicating with each other. Some are as hard as the wood of the tree they grow on, others are soft and spongy. The first are termed *gall-nuts*, and the latter *berry-galls*, or *apple-galls*. Oak-galls, put into a solution of vitriol in water, give it a purple colour, which, as it grows stronger, becomes black. They are produced by the gall-fly, and the innumerable excrescences which are seen on the leaves, branches, and roots of trees, are all the productions of this and other insects. Some of these excrescences have within them a single cavity, in which several insects live together. Others have a number of small cells, with communications between them; others have numerous distinct cavities. These productions are of various sizes, form, and consistence, some being spongy, and others, like the gall-nut, extremely hard. All are occasioned by the puncture of insects when depositing their eggs.

There are a multitude of insects which form these excrescences, the principal of which is the gall-fly or *cynips*. That which attacks the oak is of a burnished brown colour, with black *antennæ*, and chesnut brown legs and feet. The wings are white. It is small and hymenopterous. The species of oak is shrubby, inhabiting Syria and Asia Minor, and the excrescences are called gall-nuts. The female pierces a branch, and deposits an egg in the interior, around which, in the course of a few days, an excrescence is thrown out, affording nourishment to the young insect, and protecting it from external injury until it has attained its full size, when, after having undergone metamorphosis, it penetrates the sides of the excrescence, and comes into the open air. The oak which bears the gall-nut of commerce does not attain a greater height than four or five feet, and usually has very numerous straggling branches. The galls are hard, woody, and heavy, about the size of a marble, usually round, and studded with protuberances. Those which are gathered before the departure of the insect have a bluish colour.

Gall-nuts are powerfully astringent, and are frequently employed in medicine and making ink. An infusion is an excellent test of iron. They are imported from Smyrna, Tripoli, and other places in the Levant, especially from Aleppo, to which place they are brought by the Curds from the Tigris.

GALLIC ACID, derives its name from the *gall-nut*, and it may be obtained by digesting bruised galls in boiling water, with vellum-cuttings, for some hours, and then allowing the mixture to cool, and filtering it. Add to the filtered liquor a solution of acetate of lead as long as it contains any precipitate, pour the whole upon a filter, wash the precipitate with warm water, and digest it in very dilute sulphuric acid, filter, and, having saturated the clear liquor with chalk, evaporate it to dryness. Introduce the dry mass into a retort placed in a sand-bath, apply heat, and a portion of water will first rise, and afterwards a crystalline sublimate of gallic acid.

*Or*, 2, Moisten bruised gall-nuts, and expose them four or five weeks to a temperature of about 80°. A mouldy paste is formed, which is to be squeezed dry, and digested in boiling water. It then affords a solution of gallic acid, which may be whitened by animal charcoal, and which, on evaporation, yields gallic acid crystallized in white needles.

*Or*, 3, Boil 1 oz. of powdered galls in 16 oz. of water down to 8, and strain it; dissolve 2 oz. of alum in water, precipitate the alumine by carbonate of potash, and, after edulcorating it, stir it into the decoction; the next day, filter the mixture; wash the precipitate with warm water, till this will no longer blacken sulphate of iron; mix the washing with the filtered liquor, evaporate, and the gallic acid will be obtained in acicular crystals.

Gallic acid, when pure, is in whitish crystals, of a sour taste, and which exhale a peculiar smell when heated. It dissolves in about 24 parts of water at 60°, and in 3 parts at 212°. It is also soluble in alcohol aud in ether. When repeatedly sublimed, this acid is altered and in part decomposed. It consists, according to Berzelius, of

| | |
|---|---|
| Hydrogen ........ | 5·00 |
| Carbon .......... | 56·64 |
| Oxygen .......... | 38·36 |

These proportions give the number 63, as the representative of gallic acid.

When an infusion of galls is added to certain metallic solutions, it forms precipitates composed of tannin, gallic acid, and the metallic oxide, and as these are often of different colours, the infusion is employed as a test for such metals. Of these compounds, the tanno-gallate of iron is of the most importance, as forming the basis of *writing-ink and black dyes*.—*See* INK.

GALL-STONES, are calculous concretions frequently formed in the gall-bladder, and sometimes occasioning great pain in their passage through the ducts into the duodenum, before they are evacuated. Soaps have been proposed as their solvents; and a mixture of essence of turpentine and ether.

GALLEY, is a kind of low flat-built vessel, furnished with one deck, and navigated with sails and oars, particularly in the Mediterranean. In France are 40 galleys for the use of the Mediterranean, the arsenal for which is at Marseilles and Toulon, resembling the hulks in which the convicts labour and are confined. Condemnation to the galleys is a punishment whereby criminals and delinquents are adjudged to serve as slaves on board the galleys, either during life, or for a limited time. A man condemned for perpetuity is dead, in a civil sense. He cannot dispose of any of his effects—cannot inherit; and, if he be married, his marriage is null; nor can his widow have any of her dower out of his goods, which, with his lands, are thereby confiscated. It is a punishment most cruel in every sense, and in its general application to small crimes, a disgrace to civilized jurisprudence.

GARDENS OF SHIPS.—To sow in the temperate zone and reap between the tropics, is singular, yet constantly done. Our great East India ships have little salad gardens in flat wooden boxes on their poops, where the seed, acted upon by a heat increasing daily, shoots up in a surprisingly rapid manner. In these gardens the number of crops in the year are more numerous than in any spot on earth.

GARGLES.—Mix 1 dr. of pulverized capsicum, 1 scr. of salt, 4 drs. of vinegar with 1 oz. of boiling water, and strain. To be used frequently.—*Or*, mix 2 drs. of refined salt-petre, 4 drs. of honey, and 6 oz. of rose-water.

GAS.—All gas is generated by an atomic projection from the surface of fluids, sufficient to overcome the pressure of the gaseous medium in which the body gassified is placed. This propulsion is a rectilinear motion, and, as may be proved, is, in general, of intense velocity, as in water, light, &c. &c. It is a radiation, among other atoms, which *already* fill the same space; and these, reacting, turn, and deflect, the propelled atom or atoms, presenting resistance or opposition in every direction. It is easy to conceive that the result of such reactions must be a circular motion, or orbit, small or large, long continued or of short duration, as the first excitement was greater or less, and as other circumstances vary.

If 1 or 200 billiard-balls were spread over a table, and a ball, with sufficient velocity, were propelled among them, we should see that continued deflections would compel it to move in a circle. Then, in space, there is no friction, and nothing in the space but the gaseous atoms. Nor are we to consider that these are quiescent; their own motions, therefore, would, as a mean result, not diminish the force of a gaseous atom sent among them.

We thus perceive why the space filled by any gas is as the heat or first excitement. But it is not so easy to imagine why some are acid, some alkaline, &c. &c. We may speculate on forms of the atoms, on various inclinations of the planes of the orbits, and we may even conceive that atoms, moving different ways in their orbits, as right to left, and left to right, may, like acid and alkali, neutralize each other; but all these ideas are mere speculations, and it is difficult to follow up such ideal complications. It is, however, a subject on which another age, and experiments made on purpose, may throw light. The chemists of this age are too much occupied with the moon-shine of caloric, electro-motive powers, attractions, repulsions, affinities, and the like, to be persuaded to turn from these amusing visions to plain mechanical nature.

The rule for estimating the expansion of gases, by degrees of heat, is, to add the degrees which the gas is above 32 to 480, and then add any required temperature to 480; then the quotient of the first by the last is its required bulk. Suppose gas at 100, and its relative volume at 80, is required, it is $\frac{480+68}{480+48} = \frac{548}{528} = 1{\cdot}053$.

1. It appears that the atmosphere is composed of atoms in such form and motion as constitute what we call oxygen, and of other atoms called nitrogen or hydrogen.

2. That the elasticity or orbit motions of these press on the surface of all bodies, and, with the substance or carbon of the body, create local atmospheres.

3. That by friction on the surfaces of certain bodies, at right angles to the surfaces, we generate a condition of the atoms or a separation of them, which displays itself on the two sides of a plate or hemisphere of the atmosphere, and the opposed hemispheres are in contrary states, as in regard to the positive and negative conductors, the excitement of a plate of air, of glass, &c.

4. That these hemispheres, in unconfined air, expand indefinitely; but, when the air is confined by metal plates, &c. the expansive power is limited, and being bounded by their surfaces, they are called conductors; but this is only an appearance, for the forces are entirely in the air.

Hydrogen and carbon, 1 and 1, form olefiant gas; 2 and 1, bi-hydruret gas; 1 and 2, bi-carburetted hydrogen gas; and 2 olefiant and 1 water, ether.

Carbonic acid gas is composed of 100 cubic inches of oxygen 33·888 grains, and 200 carbonic oxide 59·304 grains, together 93·192 grains, the produce, and 100 of carbonic acid gas is 92·746 grains. The condensation is, therefore, 3 to 2 nearly, and perhaps exactly so.

Four volumes of oxygen gas and 3 of nitrous gas make the yellow vapour of nitric acid; and 1 of oxygen and 2 of nitrous gas make the vapour of nitrous acid. 1 of ammoniacal gas and 1 of muriatic acid gas make the powdered muriate of ammonia; with 1 carbonic acid, solid carbonate of ammonia; and with 1 of sulphuretted hydrogen, solid hydrosulphuret of ammonia. Ammoniacal gas and vapour form liquid ammonia.

The heaviest known gas is vapour of iodine, sp. gr. 8·678, 100 cubic inches, 264·679 grains.

100 cubic inches of steam are 19·062 grains.

Condensation of gas is great when, by union, they form liquids or solids. Thus 200 cubic inches of hydrogen, weighing 4·236 grains, and 100 of oxygen, weighing 33·888 grains, together

38·124 grains, form water, of which 100 inches are 57·87 oz., or no less than 25318·125 grs. Consequently, the density of the two gases are to that of the resulting water only as 38·124 to 25318·125, or nearly as 1 to 664: a surprising condensation; but, when solids three times heavier than water are formed by gas, the condensation is 2000 times! Then, as the gases are necessarily generated by motion, we cannot wonder at intense heats being generated by the sudden diffusion and economy of such a quantity of motion in all the processes in which such condensations are effected. The sufficient cause for the transfer of the motion is not yet apparent.

It should not be lost sight of that water itself, in steam, is in volume 1 to 1694. Hence, in cooling the latter to water, it condenses 1694 times, and, therefore, has 2·55 times the atomic momentum of the two gases, which, to water, are as 1 to 664.

If the waters of the seas had a 14th added to it for lakes, rivers, &c. so as to be 778 to the land 222, the ratio would be exactly 3·5 to 1; so that we should be obliged to refer to water for nitrogen and to land for oxygen, a fact which may, perhaps, be found of value.—*See* Expansion, Oxygen, &c.

*Coal* GAS, or carburetted hydrogen; the source of light and heat, and the making of which is the greatest practical improvement in the arts of life, since the fabulous days of Prometheus. The world are solely indebted for it to the persevering efforts of Winsor, who, in the first ten years of this century, laboured under increasing obloquy and ridicule, in forcing it on the attention of the world. Davy, the chemical authority *of the day*, had stated in his lectures, that when London should be lighted with gas, St. Paul's would dance a minuet with Westminster Abbey; and, hence, all the chemists, schools, and scientific authorities, united in ridicule of Winsor, his gas, and his patrons. But, as soon as he had proved its value by public lights, it was then enviously announced, that the same thing had been previously performed in sundry obscure corners; and thus, Winsor, deprived even of the honour of his enterprise, was obliged to fly the country for debts incurred in pursuing it. He died a fugitive in 1828, while 100 companies in England were profited by his ingenuity, and every town was enjoying the luxury of his system of lighting their streets and houses. The fact is, that the chemists had mystified themselves by their doctrines about caloric, &c. &c. and, though all flame is the mere combustion of gas, yet it was imagined that the gas would flame only while hot, and it required proof that it might be generated in one place, and burnt at the distance of 100 miles.

The simplest form of this gas is produced by putting some coals into the bowl of a tobacco-pipe, covering it with clay, and then placing the bowl in a fire. In a few minutes, gas will ascend through the pipe, and a candle held to it will set on fire, with a clear flame. This is carburetted hydrogen, in its gross or first state.

A gas-works is the same thing on a large scale. Coals are put into iron retorts five or six feet long, and three feet round; and these are fitted into furnaces, and brought to a red-heat. Then pipes from them convey, for six or eight hours, a stream of inflammable gas, which is cooled by being passed through a worm in cold water; and, during the condensation, &c. tar and ammonia are precipitated. The gas is then passed through, and agitated in milk of lime, or quicklime and water, and thence into a reservoir reversed in water, called a gasometer, often of unparalleled size. It is thence pressed into main pipes, for distribution in a thousand small ones through the district. To this point, Winsor had brought the invention in the gas-works at Westminster, under the patronage of Sir W. Paxton, Mr. Grant, and others.

A ton of various coals, treated in this way, produces as under, in cubic feet of gas.

| | |
|---|---|
| Cannel - - - | 12,000 |
| Staffordshire - - | 9,000 |
| Monmouthshire - | 8,000 |
| Newcastle - - | 7,500 |

Each retort holds about 100 lbs. weight, so that a ton is divided into 20 or 22 retorts, each of which produces from 350 to 600 cubic feet of gas, according to the sort of coals; and those which yield the least require to be longest in the retorts. The first and second hours yield each as much as the seventh and eighth.

Every Argand burner is reckoned to consume per hour, from two to five cubic feet, according to its size; and Accum estimates the smallest equal to three tallow candles, and the largest to six or seven candles of eight to the lb.

Hence, at four cubic feet per hour, a ton of coals will feed about 2000 lamps for one hour, or 250 lamps for eight hours; and every lamp consumes the product of 11 lbs. of coals in every hour, or in 10 hours 1 cwt. of coals.

Peckston calculates that 100 lamps or burners consume 500 cubic feet of gas per hour, and 1600, the produce of a ton of coals in an hour, or 8000 cubic inches. If so, then every lamp consumes at this rate 14 lbs., or the eighth of an cwt., in every hour, equal to one lb. of candles.

The service-pipes are meted in the

London companies in this proportion. A pipe of one quarter of an inch bore supplies 20 feet of gas per hour for four lamps; one three-eighths 50 feet for 10 burners; and one of half an inch bore 90 feet per hour, for 18 burners. Calculated in this way, a pipe from the gasometer of six inches, is found sufficient for 18,000 feet per hour, or 3600 burners; and one of 10 inches sends out 50,000 feet per hour, enough for 10,000 burners. *Peckston.*

In Glasgow, URE states, that one lb. of coals, which, in London yields but $\frac{7}{16}$ of a cubic foot per hour, yields one cubic foot, or $\frac{16}{16}$ths, a difference of 16 to seven; or, as he says, "fully double the London quantity." The Scotch are celebrated for severe economy, but this is a trait worthy of imitation. He superadds, that the light of Glasgow gas to English is also as five to four, making the whole difference 80 to 28. If Professor Ure is not blinded by the usual nationality, our gas committees ought forthwith to make a journey to Glasgow.

A manufactory, gentleman's seat, parish-church, workhouse, hospital, or village, may, with one retort, produce, for eight hours, 50 feet of gas, equal to 10 or 12 burners, by an apparatus not costing above 80*l*., pipes and lamps included.

The cost would be as under:

| | |
|---|---|
| Furnace - - - - - | £10 |
| Retort, &c. - - - | 5 |
| Pipes, &c. - - - - | 12 |
| Purifying vat - - - | 5 |
| Gasometer (·8 by 8). - | 15 |
| Pipes for service - - | 15 |
| Lamps - - - - | 8 |
| Sundries - - - - - | 10 |
| | 80 |

The cost per eight hours, or night, would be the 20th of a ton of coals, a superintendant, 3*s*., wicks, &c. 6*d*.; and in a third of the kingdom, coals are not above 5*s*. per ton, or 3*d*. per cwt. In truth, for 4*s*. per night, as much superior light would be distributed, as in candles or oil would cost treble the sum; and in villages, in or out of roads, it would be a luxury above all price.

Two-thirds of the coals would be coke for use, and there would also be products of tar, and of ammonia for excellent manure, worth together 1*s*. 6*d*. out of the 4*s*., which would more than pay for the coals used to heat the retorts; the furnace consumption being about a third of the quantity distilled in the retort, and also for the lime, of which, 10 lbs. would be wanted for 400 feet of gas.

From two to three parts in 100 of the *impure gas* from cannel coal, are sulphuretted hydrogen, and from two to five parts in 100, are carbonic acid gas. These are absorbed or neutralized in the lime-water, and become in a mean state 15 olefiant gas, 80 carburetted hydrogen, and five azote; which, in combustion, consume, according to Henry, 200 of oxygen, and generate 108 of carbonic acid gas. Other coals, in the impure state of the gas, are two of sulphuretted hydrogen, and two of carbonic acid; when purified, nine of olefiant, and 91 of carburetted hydrogen; and fix, or consume, 168 of oxygen gas, and create 93 of carbonic acid gas.

Every lb. of coals would yield, according to its quality, and the skill of the operator, from three to four feet of gas; and a light equal to two mould candles would consume about a cubic foot per hour. This, therefore, may be the basis for apparatus of all sizes.

Now these data of Dr. Henry, afforded by Phillips' and Lee's gas in the third hour, illustrate the true theory of heat and light. The cannel coal yielded 95 of inflammable gases; that is, such as when excited do not permit the circulation of oxygen atoms, and by fixing them, transfer their motion or heat. It also yielded five of azote, which would neutralize 20 of the oxygen, and reduce its operative quantity to 180.

Then it appears that the common coal yielded 100 of inflammable gases, but fixed only 168 of oxygen. Taking this for granted, the heat of the two gases would be as 180 to 168, or 15 to 14, as the ratio of heat.

The light being however an *effect* of the entire excitement at the spot, we find that the carbonic acid gas created was as 108 to 93, *i. e.* as 36 to 31. And multiplying the two ratios, it is 540 to 434, or nearly as nine to 7·23, for the ratio of light.

The proportion of gas generated was as 7 to 6, and then uniting this with the previous ratio, we get 63 to 43·38, or 3 to 2 nearly, as the whole advantage of cannel-coal over the Clifton-coal used by Phillips and Lee; and as matter of fact, Henry considers this to be the difference between them. In fact, a second passing through the fresh-burnt lime and water, reduced the oxygen to 175; and, if as above, 175 was taken for 180, the ratio would be 3 to 2 exactly.

Within four miles of St. Paul's, there are every winter's night half a million of gas-burners, from 6 to 12 hours each, consuming 40 cubic feet of gas, the tenth of an cwt. of coals; *i. e.* in all, 2500 tons per night, for 182 nights, or 450,000 tons; and half the quantity for 185 other nights, making 680,000 tons per annum. Taking the coals at 28*s*., this is 850,000*l*., and other expences of the gas-works at half as much more, the outgoings are 1,275,000*l*. Then, taking their returns at 3*l*. 10*s*. per light, 1,750,000*l*., and the products of 250,000, these gigantic establishments must net three quarters of a million per annum. The manufacture of 20 millions of cubic feet of gas per day is a wonderful concern.

Earthen retorts yield 20 per cent. more gas than iron ones; but they exhaust the coke proportionally.

Mr. J. Down, of Leicester, has patented improvements in making gas for illumination, and in the apparatus for the same. In the distillation of coal, the gaseous product is so crude as to require a subsequent process of purification, which is usually effected by passing it through a solution of lime in water. But Mr. Down's method of superseding the latter operation, consists in conducting the products of the first distillation (made in the common way) immediately into another retort, containing a series of strata (or an extensive stratum) of coke or charcoal in a state of ignition, through which they are made to percolate; by these means the gas is rectified, and the tar and ammonia are decomposed, thereby yielding a considerable additional quantity of gas.

GAS BURNERS.—Mr. Lowry, of Greenock, gives the following account of experiments to ascertain the best means of combining economy in the consumption of gas, with the obtaining the greatest brilliancy of flame. Burners, whose circle of holes were 5-8ths of an inch in diameter, were tried with from five to fifteen holes in the circle, and the consumption was always the least with the greatest number of holes, though no great difference was observed when the holes were so near each other as to allow the jets to be perfectly united. An enlargement of the holes also produced a saving. When the central air aperture was stopped, or partially so, the flame rose considerably, but was conical and dull; but when the central and outer apertures were proportionally reduced, the flame became bright and cylindrical. On shortening the glass chimney, more light was obtained from a given quantity of gas; and on taking off the glass altogether, less gas was consumed in proportion to the light given out. A perforated plate was laid on the top of the glass chimney, and the quantity of light was increased; and the same effect took place by using a glass whose diameter at top was equal to the openings found most advantageous in the perforated plate. On doubling the height of the glass chimney, the flame fell to about one-half of its former height.

From the trials made by Mr. Lowry, he drew the conclusion that the greatest effect was produced when the holes were numerous, and rather large than small, the central aperture narrow, and the glass near the flame, the outer aperture being in such proportion to the inner as to keep the flame cylindrical. This construction, however, when carried to the extreme, being attended with the practical disadvantages that burners being often placed in exposed situations, the least motion of air brings the flame in contact with the glass in such a way as to produce smoke, and the glass being intensely heated, is more liable to be broken. He found it answered the purpose fully as well to enlarge the air aperture, making the glass chimney rather wider and shorter, reducing in this manner the speed of the air through it.

Experience shows, that burners made on the plan last above described, answer the purpose of requiring less gas than other burners, and giving at the same time as brilliant, and perhaps a more beautiful flame.

*Heating by Gas.*—Water may be heated by gas-lamps of shops, simply, by having a double funnel over the flame, the vacuity filled with water, and communicating with the reservoir to be heated by a going and returning-pipe. No house in London, having a shop, need require any fire-places or chimneys, but for the purpose of cookery: and, indeed, were gas only a little cheaper, fires in large cities might be dispensed with altogether. It would be easy to render gas an elegant substitute for a fire in a drawing-room: while the heat, as it passed up the chimney, might be communicated to pipes connected with reservoirs of water for heating other parts of the house. Most kinds of cookery might also be effected by gas; and what could not, would only require a little coke or charcoal. The gas-lights of churches and other public buildings might, in many cases, communicate heat as well as light, simply by having a double spiral funnel over the flame, and a going tube, a returning tube, and a pressure or balance tube, communicating with a reservoir; which reservoir might either be under the floor, or in any part of the house, between the floor and the roof.

GAS-WATER, rendered a hydrosulphuret of lime, by the purification, is found highly useful in cutaneous disorders.—*Paris.*

GELATINE, an animal product, resembling the jelly of fruits, considered as nutritive. It is prepared in digesters, from remains of animal matters, and an attempt has been made in Paris to feed the poor, and especially the hospitals, with the gelatine of bones, and it has also been made into biscuits for the troops.

Gelatine brut fin, is from the skulls,

blade-bones, and shank-bones of sheep, the ends cut off, the bones cut down the middle to remove the fat, steeped in muriatic acid, then in boiling water a few minutes, wiped carefully, dried, shaked together in a bag to remove the internal pellicle, cut across, or into dice, to disguise them, and finally dipped in a hot solution of gelatine to varnish them. It is used to make soup, keeps better than the cakes of portable soup; and, less carefully prepared, makes carpenters' glue for fine work.

GENEVA, or Hollands gin, is made by mashing 120 lbs. of malt with 240 lbs. of rye flour, in 480 gallons of water at 162°. Yeast is added at 80°: and in two days the fermentation raises it to 90°. The whole, grains and all, is then subjected to three distillations, and before the last, juniper berries and hops are infused. Gin is the curse of the populace in Britain, but encouraged for the sake of revenue.

GENTIAN, a powerful stomachic and tonic, has hitherto been used as an extract, in water or proof spirit, but its astringent principle has been decomposed as an alkali, and it may be used in a concentrated form, as *Gentiana.*

GENTIAN ROOT, is one of the most valuable tonics, and may be taken as an infusion or tincture, in combination with other medicines, in doses of 10 gr. to two scruples.

GEOLOGY, the structure of the earth from the surface downwards, and is so intimately connected with mineralogy, and a subject so interesting, as well as useful, that, in such a work as this, it merits some brief observations.

Formerly, men used to discuss the eternity of the earth, but as all things are in a constant state of change and progression, and as matter assumes a constant succession of new forms, an eternity, in present forms, is to be regarded as an absurdity.

We have, however, abundant data in the materials of the earth, in the imbedded substances, and in the remains of corals and zoophites, of vegetables, and of extinct races of animals, by which to infer, with *accuracy*, the natural history of the earth in various periods.

We find that the uniform lowest strata are composed of crystalline rocks called granite, formed of three substances, quartz, feldspar, and mica, which granite, varied in these constituents, becomes gneiss, or mica slate, but always in crystals. And, since we know that crystallization is an effect of the cooling of a melted or fluid mass, it becomes evident that the earth was once nearer the sun, either as a planet or a comet, by which alone these substances could have been in the required fluid state.

How the earth could have acquired such heat as to render the primitive rocks fluid must ever be matter of speculation; but, as water is a product of combustion, we may perhaps infer, that in this way water would constitute such a dense atmosphere as we see round comets; and, as the cooling process proceeded, the collapsing of the atmosphere would generate the seas.

These, in turn, would by abrasion generate the transition rocks lying on the primitive, and a long and varied process would generate the varieties of rocks, substances, and soils, which now constitute the surface.

Vegetation, animalization, and, indeed, all organizations, seem to have increased in complication, in periods measured by the progression of the line of Apsides, one end of which, the perihelion, in demanding the increased reaction of the waters, would be the means of transporting them into each hemisphere, in every 20931 years. From this cause, the land and sea preponderate for 10,465 years, and produce that order and disorder in the strata, &c. &c. which we every where witness, as a consequence of the physical necessity that the orbit of a mass should be an ellipse.—*See* GRANITE, STRATA, &c.

GERMAN PASTE, *(For Birds.)*—Mix two lbs. of pease-meal, three oz. of fresh butter, and one lb. of blanched sweet almonds well together, with a little honey and shreds of saffron-cake; and granulate through a cullender.

GHOSTS, DREAMS.—These are odd words in a book professing wisdom, but owing to the follies of the nursery, it is proper to state, that faith in ghosts, dreams, and omens, always betrays the grossest superstition, and lowest ignorance. The only ghost ever seen was the effect of some diseased organ, as the eye or ear, of some fever, or some hallucination of mind. Dreams are effects of indigestion, or imperfect sleep, proofs that different parts of the brain have different functions, and that the retentive part may be in action, while the volition is inert. Signs and omens come like fortune-telling, within the doctrine of probabilities, but have no controul of the events, as cause or effect, and therefore are always absurd. The march of nature is too grand and sublime for such oddities to have any place but in the fancies of weak minds. Nature is always the same, to-day as yesterday, and to-morrow as to-day, by night and by day, in darkness and in light, in a church-yard, and on the mountain-top; and there are no miracles, except to the ignorant and credulous, or the idle and diseased.

GILDING, is the art of applying gold leaf or gold dust to surfaces of wood, stone, or metals. It is performed either upon metals, or upon wood, leather, parchment, or paper; and there are three distinct methods in general practice; namely, *wash*, or *water gilding*, in which the gold is spread, whilst reduced to a fluid state, by solution in mercury; *leaf gilding*, either burnished or in oil, performed by cementing thin leaves of gold upon the work, either by size or by oil; *japanner's gilding*, in which gold-dust or powder is used instead of leaves.

In *gilding wood*, the operator should be provided with a cushion, made of a board about 10 inches square, covered with leather, and lightly stuffed with cotton, and a thumb-piece at the back; also, with a *tip*-brush, a pallet-knife, and a dabber, or silk bag filled with cotton. The pattern to be gilt is then exactly washed with japanner's gold size, (linseed-oil and gum animi, thinned with oil of turpentine,) and the gold leaves being cut on the cushion with the pallet-knife, are transferred by the tip-brush to the sized surface and tapped with the silk bag, and left to dry.

In covering surfaces with gold, the size is made of 3 boiled oil, 1 japanner's gold size, with yellow ochre ground in boiled oil. Two separate washes of this must be applied to the pattern, and before quite hard, the gold leaf laid on. Other size is made by grinding red lead with thick drying-oil, and diluting with turpentine; and, in other cases, with mere glue.

Iron and steel are gilt by simply dipping. The solution in aqua-regia is to be evaporated till it crystallizes, and then, if dissolved in water and alcohol, the iron may be dipped. But, if sulphuric ether be added, polished steel will be gilt by simple immersion.

Silver is gilt, by a solution of the gold in a menstruum of nitric acid, sal ammoniac, and corrosive sublimate. It blackens the silver, but a red heat restores the gold colour.

The mercurial amalgam can be applied to copper, or brass, or silver, by washing the surface with a solution of dilute sulphuric acid and mercury. The amalgam is then evenly applied with a wet brush of brass wire. The heat of a furnace evaporates the mercury, and leaves the gold. Rub with gilders' wax, and burnish with steel.

Iron is gilt by heating it blue, and laying on gold leaf, burnishing, and heating. Repeat till perfect.

Copper buttons are gilt by putting them in nitric acid, and then burnishing on hard stone. Then stir them in nitric solution of mercury till white. The amalgam of gold is then mixed with nitric acid, and the buttons being well stirred the gold attaches. By heating, the mercury is made to run, when, after trituration in a hairy bag, further heat evaporates it, and the buttons are burnished.

Gilding in cornices, &c. is effected by priming with boiled linseed-oil, and carbonate of lead. The surface is then covered with gold size, on which slips of gold leaf are pressed with cotton. The edges are then brushed off. Burnished gilding requires priming with gum, and bole must be mixed with the gold size.

*Gilding in oil.*—1. The first operation is to give a priming coat of colour, formed by grinding white lead in oil, rendered drying by boiling with litharge, and tempered afterwards with linseed-oil, adding a little fat oil, and a very small portion of spirits of turpentine. 2. Grind calcined white lead very fine in fat oil; this must immediately be tempered with oil of turpentine, as it is subject to become thick very quickly. Three or four thin coats of this are to be given very evenly in the ornaments, and in all parts intended to be gilt. Care must be taken in applying the colour to the deeper parts of the work, that it may be even and perfect. This is the *teinte dure*, or hard ground. 3. The gold colour or size, previously strained through fine linen, is then to be laid on, very thin and even, with a soft brush which has been used for oil colours. A smaller brush must be used for the deeper parts of the sculptured or other ornaments, carefully observing to remove any hairs which may be detached from the brush. 4. Where the size is so far dried as to become tacky, the gold leaf is to be spread upon the cushion, and divided with the knife; the gold is placed on with a small block of wood, faced with cloth, called a *palette*, and lightly pressed with cotton, repairing where necessary with pieces of gold cut small, applied by a badger's hair-pencil. 5. If the articles gilt are to be exposed to the weather, as balconies, gratings, statues, &c. they ought not to be varnished, as gilding in oil is more durable without than with varnish. The heat of the sun will, after a heavy rain, cause gilding covered with varnish to craze or crack over its whole surface. Gilding in the interior of a building, as on the rails of stair-cases, &c. should have a coat of spirit-of-wine varnish, drying it by means of a chafing-dish, and then applying a coat of oil varnish. The beauty of oil-gilding depends greatly upon the manner of varnishing it.

*For gilding metal buttons.*—To 4 oz. of yellow melted bees-wax add, in fine powder, 1½ oz. of red ochre, 1½ oz. of verdigrise, calcined till it yields no fumes, and ½ an oz. of calcined borax, and mix them well. It is necessary to calcine the verdigrise.

*To exalt the colour of green gold.*—Take saltpetre 1 oz. 10 dwts., sal-ammoniac 1 oz. 4 dwts., and verdigrise 18 dwts., and dissolve a portion of the mixture in water, as occasion requires.

*To exalt the colour of yellow gold.*—Take saltpetre 6 oz., green copperas 2 oz., white vitriol and alum, of each, 1 oz. If the colour be wanted redder, a small portion of blue vitriol must be added. To be dissolved in water, as wanted.

These two last compositions must be applied to the surfaces of the gilt works, either with a pencil, or by dipping them; a proper degree of heat must then be used to cause them to assume a black colour, when they must be quenched, or cooled, either in vinegar or water.

Gilding japan-work is performed with japanner's gold size; and for dead gold it should be used with turpentine only, but for lustre with fat oil only.

*Gilding earthenware and porcelain.*—Take 2 drs. or 5 dwts. of pure gold and triturate in a porcelain mortar carefully, until very fine; add, at distinct times, 1, 2, and 2 dwts. of pure mercury, and mix well together; then add 10 grs. of white oxide of lead. *Or*, exclude the lead, and 1 dwt. of the mercury, when a strong body of gold is required.

On a glass plate, long, and very carefully grind for use.

When the gold (as on some occasions) contains an alloy of silver, less mercury must be taken, and lead wholly excluded.

In executing the superior specimens of this art, men are employed; and in many of the porcelain manufactories may be seen specimens of the high excellence of which it is susceptible, in flowers, landscapes, and portraits. Other less delicate patterns are the work of young women; of whom, great numbers provide for their comforts by these employments.

When the *gilded* ware has been through the muffle, and is cool, the gold is burnished with agate or bloodstone; the ware is then wrapped in tissue paper, and carefully packed for home, or foreign markets.

On some of the least valuable porcelain, leaf-gold is fixed by being placed on a warm size, formed of these components. Boil together half a pint of pure linseed-oil, ½ oz. of gum arabic, gum benzoin, and acetate of lead severally; and after being well boiled, cool; lay evenly on the ware, heat the whole a little, add the strips of leaf-gold, and carefully place for sale.

*To gild with burnished gold.*—Give 5 or 6 coats of size and whiting. First with varnish of Armenian bole, wax, and size. Wet with water, and lay on the gold, and in a few hours burnish with agate.

*To gild the edges of books.*—Wash them, in the press, with Armenian bole, sugar-candy, and white of eggs. Wet with water and lay on the gold leaf, and burnish with a dog's tooth, or steel tool.

*Golden articles of jewellery.*—The two best mixtures, for the purpose of giving a good gold colour to articles of jewellery, are as follows:—

| | *Parts* |
|---|---|
| Muriatic acid at 22° | 10 |
| Oil of vitriol | 4 |
| Crystallized boracic acid | 2 |
| Water | 150 |
| *Or,* | |
| Acid muriate of alumine (liquid) | 13 |
| Crystallized sulphate of soda | 4 |
| Crystallized boracic acid | 3 |
| Water | 150 |

Either of these mixtures, with 20 grs. of neutral muriate of gold, constitutes the bath, which is to be used in the following manner:—A large glass mattrass, carefully luted at the bottom, is placed over a circular furnace, so as to have heat readily applied to it; the solution is to be put into it, and when at the boiling point, the pieces of jewellery, previously cleaned and picked, are to be introduced, suspended upon golden wires. After a few minutes, a copper wire is to be immersed, and left until the gold has acquired a deep colour; it is then to be withdrawn, but the articles still left in until they have acquired the colour necessary. They are then to be put into warm water, acidulated by sulphuric or acetic acid, to remove particles of oxide of copper, washed in clean warm water, and dried near a fire. Generally, a single operation is not enough; for, as a long immersion produces harm from the oxide of copper, it is better to shorten it, and repeat the operation.

*Gold size.*—Mix 16 oz. of linseed-oil, 8 oz. of turpentine, 2 oz. of asphaltum, and 1 oz. each of brown umber and of red lead. *Or*, Melt together 1 oz. each gum asphaltum and anime; ½ oz. each of litharge, red lead, and brown umber; 4 oz. of linseed-oil and 8 oz. of drying-oil; strain.

*Gilders' wax*, is 4 lbs. of bees-wax, a ¼ of verdigris, and also of sulphate of copper, kept in a red-heat till the wax has evaporated.

*Shell gold* may be obtained by amalgamating the metal with 8 parts of mercury in a crucible, and then evaporating the mercury. *Or*, gold leaf may be triturated with gum-water, and the gum dissolved and poured off.

GILLY-FLOWERS, (Dianthus) afford

a pleasant astringent infusion, and yield a fragrant essential oil.

GINGER-BEER.—½ lb. white sugar, ½ oz. of cream of tartar, 1 oz. bruised ginger, and 1 gall. boiling water. Ferment with yeast 24 hours.

*Ginger-beer powders* are made in the following proportions: white sugar 1 gr. 2 scr., ginger 5 gr., sub-carbonate of soda 26 gr. in blue paper; and 30 grs. tartaric acid in white paper. Half pint of water.

GINGERBREAD, is a compound of flour, treacle, butter, potash, and alum. The last are melted in warm water, mixed with the melted butter and the treacle, and kneaded with the flour. It then stands a week for the potash and the treacle to generate the carbonic acid gas of fermentation.

*Or*, 2, it may be made of 4 lbs. of flour, an oz. of carbonate of magnesia, and ½ an oz. of tartaric acid. Stir in the magnesia with the dry flour. Dissolve the tartaric acid in water, and pour it on with the treacle and butter as above.

*Or*, 3, Dissolve ½ an oz. of potash, and a little alum, in hot water; they then melt it in an oz. of butter, and knead it up with quick strokes, together with ¾ of a lb. of treacle, and an oz. of mixed spices, of which the composition is variable; but for the most part consists of ginger, canella, nutmegs, and the four spices. *Or*, 4, Take 2 lbs. of flour, ½ an oz. of magnesia, 1½ lb. of treacle, 2 oz. of butter, and the necessary quantity of water to knead it, holding in solution a ½ of an oz. of tartaric acid, form a paste which will rise in half an hour.

*Ginger tincture.*—In 1 lb. of proof spirit of wine, infuse 1 oz. of ground ginger. *Or*, (*Oxley's concentrated essence of ginger*). Use strongest alcohol instead of the preceding.

*Ginger, to preserve.*—Take green ginger, part it neatly with a sharp knife, throw it into a pan of cold water as it is pared, to keep it white. Boil it till tender, changing the water three times; each time put the ginger into cold water, to take out the heat or spirit of the ginger: when tender, throw it into cold water. For 7 lbs. of ginger clarify 8 lbs. of refined sugar; when cold, drain the ginger, and put it in an earthen pan, with enough of the sugar cold to cover it, and let it stand two days: then pour the syrup from the ginger to the remainder of the sugar, boil it some time, and when cold pour it on the ginger again, and set it by three days at least: then take syrup from the ginger, boil it, and put it hot over the ginger. Proceed in this way till you find the sugar has entered the ginger, boiling the syrup, and skimming off the skum that rises each time, until the syrup becomes rich as well as the ginger. If you put the syrup on hot at first, or if too rich, the ginger will shrink, and not take the sugar.

GLASS, is made by melting silicious earth or sand, alkaline substances, and metallic oxide, at a white heat. The manufacture of glass is now brought to a high degree of perfection. Glass-houses are commonly large conical buildings, from 60 to 100 feet high, and from 50 to 80 feet in diameter.

The furnace is in the middle, over a large vault, which is connected with it by means of an opening. This opening is covered with an iron grate, upon which the fire is made, and it is kept up by the draught of air from the vault.

The most important part, however, of the apparatus of the glass-house is the crucible, made from clay, found at Stourbridge. This is first pounded fine, then sifted, moistened, and worked into a thick dough. Sometimes old crucibles are used, which are broken into powder, and then mixed with a red clay. Some pots, for bottle and flint glass, are made 40 inches deep and wide. They are from 2 to 4 inches in thickness. They remain several days at a white heat, before they are placed in the furnace.

The basis of glass is *silica*. When flints or quartz are used, they are first reduced to powder by being heated red-hot, and then plunged into cold water. This causes them to whiten and fall to pieces, after which they are ground and sifted. The second ingredient is potash or soda. The alkali used is more or less pure, according to the fineness of the glass to be made. Lime is often employed in small quantities; also borax.

Of the metallic oxides added in different cases, the deutoxide of lead is the most common. It renders flint glass more fusible, heavy, and tough, more easy to be ground and cut, and increases its brilliancy and refractive power.

A small quantity of black oxide of manganese renders the glass more transparent; too much gives a purple tinge, which, however, may be destroyed by a little charcoal or wood.

Arsenious acid (white arsenic), in small quantities, promotes the clearness of glass; too much of it gives the glass a milky whiteness. Its use in drinking-vessels is not free from danger, if the glass contains so much alkali that any part is soluble in acids.

The various materials are carefully washed, and, after the extraction of all the impurities, are conveyed to the furnace in pots made of tobacco-pipe clay. The produce of this process is called the *frit*, which is again melted in large pots or crucibles, till the whole mass becomes beautifully clear, and the dross rises to the top.

*Blowing* is the next process, which, in round glass, as phials, drinking-glasses, &c. is thus performed:—The workmen dip the end of long iron pipes, red-hot, into the liquid glass, then roll it on a polished iron plate to give it an external even surface; they next blow down the iron pipe, till it enlarges the metal like a bladder, and, if necessary, roll it again on the iron plate, and proceed to form it into a globular form, or any other one required. The glass is then transferred from the blowing-pipe, by dipping the end of another iron rod into the liquid glass, which adheres to the heated rod, and with which the workman sticks it to the bottom of the vessel; then, with a pair of pincers, wetted with water, he touches the neck, which immediately cracks, and, on being slightly struck, separates at the end of the blowing pipe, and becomes attached to the iron rod. The vessel is next carried up to the mouth of the furnace, to be heated and softened, that the operator may finish it. If the vessel require a handle, the operator forms it separately, and unites it while melting hot, forming it with pincers to the requisite shape and pattern.

*Annealing*, is the removing of the glass, after it has been blown or cast, into a furnace, whose heat is not sufficiently intense to melt it; and gradually withdrawing the article from the hottest to a cooler part of the annealing chamber, till it is cold enough to be taken out for use. If cooled too suddenly, it is extremely brittle.

*Colouring.*—The different coloured glasses owe their tints to the different metallic oxides mixed with the materials while in a state of fusion. In this manner are made those elegant *pastes*, which so faithfully imitate, and not unfrequently excel, in brilliancy, their originals, the gems of antiquity. The glass, however, for this purpose, is prepared in a peculiar manner, and requires great nicety. It combines purity and durability.

*Opaque* glass is made by the addition of the oxide of tin, and produces that beautiful imitation of enamel which is so much admired. Dials for watches and clocks are thus made.

*Bottle-glass* is made of soap-boilers' waste and river sand, or sand and lime with clay and salt, mixed, evaporated, and fritted. *Common window-glass*, of 2 soap waste, 1 *kelp*, and 1 sand. *Super window-glass*, 25 sand, 12 sulphate of soda, or Glauber's salt, 4 carbonate of lime, or lime unburnt, and 1 of charcoal; or 2 purified sand, 3 strong kelp. *Plate, or sodaic glass*, is sand 100, sub-carbonate of soda 55, unslaked lime 9, nitre 4, and powdered glass 60. The product is three-fourths. *Flint, or litharge glass*, is 10 fine sand, 6 red lead, 3 pearl ash, a half-part oxide of manganese.

*Grinding* and *polishing* give plate-glass a fine lustre. The grinder takes it rough out of the hands of the caster, and, laying it upon a stone table, to which it is fixed with stucco, he lays another rough glass, half the size of the former, upon it. To the smaller glass a plank is fastened, by means of stucco, and to the whole a wheel, made of hard, light wood, about six inches in diameter, by the pulling of which from side to side, and from end to end, of the glass, a constant attrition is kept up; and, by allowing water and fine sand to pass between the plates, the whole is very finely polished; but, to give the finishing polish, powder of smalt is used. As the upper glass grows smoother, it is taken away, and a rougher one substituted in its stead; and so on till the work is done. Except in the very largest plates, the workmen polish their glass by means of a plank, having four wooden handles to move it; and to this plank a plate of glass is cemented, as above.

Various *Ornamental forms* are given to the surface of glass vessels by metallic moulds. The mould is usually of copper, with the figure cut on its inside, and opens with hinges to permit the glass to be taken out. The mould is filled by a workman, who blows fluid glass into its top. The chilling of the glass, when it comes in contact with the mould, impairs its ductility, and prevents the impression of the figure from being sharp. Some moulds, however, are made in parts, which can be suddenly brought together on the inside and outside of the glass vessel, and produce specimens nearly equal to cut glass.

*Cut glass*, so called, is produced by grinding the surface with small wheels of stone, metal, or wood. The glass is held to the surface of the wheels. The first cutting is with wheels of stone; then with iron, covered with sharp sand or emery; and, finally, with brush wheels, covered with putty. A small stream of water is kept continually running on the glass, to prevent the friction from exciting too much heat.

Glass may be ground on any coarse grained stone, with sand, or emery and water. Flat pieces of glass may be divided in any shape, by making a notch with a file, and carrying a piece of hot charcoal before the line in which it is intended the fracture should proceed The charcoal must be kept alive with the breath, and the progress humoured by experience. Tubes, &c. are cut with a file all round, and then broken. They are closed, bent, &c. by exposure to the blow-pipe, or spirit-lamp, with the address which experience only can teach. For straight lines, the diamond and flat ruler is the glazier's efficient tool, and a pair of pliers chips off corners and rough edges.

Glass soiled with resin, turpentine, &c. should be washed with a strong solution of potash, or some sulphuric acid. Wires with tow clean tubes. Oil in flasks, &c. is removed with nitric acid and heating over a lamp.

Glass should always be so heated that all the adjacent parts may become hot together; hence, thin glass is less apt to break by heat than thick. In heating ends of tubes, &c. begin 2 or 3 inches above the end.

If a tube, or goblet, or other round glass body is to be cut, a line is to be marked with a gun-flint having a sharp angle, an agate, a diamond, or a file, exactly on the place where it is to be cut. A long thread covered with sulphur is then to be passed two or three times round the circular line, and to be inflamed and burnt; when the glass is well heated, some drops of cold water are to be thrown on it, when the piece will separate in an exact manner, as if cut with scissors. It is by this means that glasses are cut circularly into thin bands, which may either be separated from, or repose upon each other, at pleasure, in the manner of a spring.

*Drops of glass*, which have been let fall, while melted, into water, commonly called *Prince Rupert's drops*, assume the form of an oval body, terminating in a long slender stem. They are also called *glass tears*. The large part may be struck with a hammer, or filed, without breaking; but if the stem is broken the crystal is broken, and the whole flies to pieces.

*Glass galls*, a substance which floats upon melted glass, like scum or froth. It is alkaline, and attracts moisture from the air. It is chiefly used for soldering silver, stands a strong heat, is a good flux for substances difficult to fuse, and keeps them long in a state of fusion. Potters also use it for glazing.

*Glass threads*.—The great ductility of glass enables it to be drawn into the finest threads. A piece of glass is held over the flame of a lamp, till it becomes soft: a hook is then fixed into it, and it is drawn out into a thread as fine as a spider's web.

The Editor, in 1828, viewed a glass manufactory at HUNSLET, on the same extended scale as most of the Leeds manufactories. "There are made at it bottle-glass and flint-glass, for which there are two four-pot furnaces for the former, and one seven-pot furnace for flint-glass. One of the proprietors, Messrs. BOWER and SONS, shewed me through it. Bottle-glass is made of soap-ashes, (containing carbonate of lime, some sulphate of potash, and a little soda) and river, or sea-sand. These are mingled in the proportions of 2 to 1, and to a ton half a hundred of kelp is added. This mixture is exposed in a reverbatory furnace to be calcined, and is then removed, and in open pots is exposed in a glass-house furnace to the highest degree of heat, from coals, for 12 or 14 hours. The fluid vitrification takes place in an hour or two, but the sand is not entirely dissolved, and the air-bubbles are expelled in less than 12 hours. Black, or brown bottles, are made by throwing in red brick-dust, and a green tinge is given by adding more kelp.

"Flint-glass is made of 2 of red oxyde of lead, 1 of carbonate of potash, or pearl ash, 3 of pure quartz, or silex, free from iron, 1-11th of salt-petre, and 1-400th of black oxyde of manganese. This batch, as it is called, is exposed in close pots to the highest possible heat, for forty or forty-five hours, when the combination and vitrification are complete.

"Messrs. Bower blow every variety of glass service, and have a cutting shop, where, by lathes and wheels of various materials, urged by a small steam-engine, the most elegant ornamented articles are finished for sale. The consumption is chiefly confined to Yorkshire.

"They have also an ingenious artist engaged in painting, or staining glass for churches, libraries, and stair-cases. I saw a great variety executed in the best style. The materials chiefly used are chemical preparations of silver, as phosphates, muriates, and carbonates, with oxydes of other metals. Red is produced by muriate of silver; orange by the same, and red ochre; yellow, with phosphate of silver; green, with blue on one side, and yellow on the other; blue itself with cobalt, red lead and silex; purple, with nitro-muriate of gold, precipitated with nitro-muriate of tin, and fluxed with red lead and borax; violet requires the addition of some leaf silver; black, by black oxyde of iron and cobalt, fluxed as above. Brown is produced by iron in low oxydation.

"When the subject is drawn with these compositions, the plate is exposed in an iron oven with shelves, placed in a furnace, and kept red-hot for an hour or two, and the colouring substances are then vitrified with, and united with the glass.

"These works employ 60 or 70 men, from 16*s*. to 35*s*. per week, and it pays 6 or 800*l*. every six weeks' setting, to the excise, and for this fiscal purpose three officers attend per day.

"The caloric men might get a lesson here. They will see that Messrs. Bower do not depend on latent caloric, but on subterranean passes, or caves, through which the air passes for fixation in the fire, the parting with the motion of its atoms being a gain of atomic motion in the fire; and, hence, its intense heat.

"Adjoining there is a crown-glass manufactory, belonging to Mr. Joshua Bower, consisting of two furnaces of 6 and 4 pots. I learnt that crown-glass is made here of kelp and sand, in the proportions of 2 to 1. It is calcined in the reverbatory furnace, and then thrown into the melting-pots. In 30 hours the highest heat perfects the vitrification.

"Plate-glass is not made here, but I learnt that the materials are carbonates of soda and lime, and fine white sand, with manganese to reduce the blue, and increase the transparency."

*Glass-wort*, or *saltwort*, *(salsola kali)*. Emmenagogue, diuretic, and hydragogue. It yields barilla by being burned, and *salsola soda*; or *Alicant glass-wort*. All yield much barilla by burning.

GINSENG ROOT is cordial, and aphrodisiac, when sliced and made in tea.

GLAZIERS' PUTTY.—Whiting and linseed drying-oil, beaten together some time.

GLAZING EARTHENWARE AND PORCELAIN.—In the bisquet state, earthenware and porcelain will adhere to the tongue, and imbibe moisture. The tendency of the earths to absorb water is the cause; and the ware in this state would not retain water and many other liquids. Hence, there is necessity for an artificial vitrified covering, whose components are so adapted to those of the body as to be equally affected with them by change of temperature, and preserve equality of expansion or contraction.

We have not yet discovered a body and glaze that will be complete ware by once baking. The components of the present bodies do not sufficiently conglomerate to remain unaffected by the moisture of the glaze, but the articles become soft, and either shrink, or alter their figure. The only probable suggestion I have heard is:—Grind very well some of the flesh-coloured felspar from Montgomeryshire, precipitate whatever iron may be in the mineral, then add 8 per cent. of ground native carbonate of barytes, and 1 per cent. of cobalt blue calx, mix in water for *dip and glaze*, and fire only once. Feldspar is the glaze of nankin porcelain.

The manufacturers have their particular *glazes*, for certain bodies. The several components are carefully proportioned, then ground to a pulpy state, almost impulpable between the thumb and finger; this is mixed with a certain quantity of water, and kept agitated to preserve uniform suspension. The *dipper* places nigh him a board covered with bisquet ware, and another with a number of small pegs or nails. He immerses (or *dips*) each article, with a suitable motion to cover the whole, then places it on the pegs to drain. The water is imbibed by the pores of the ware, and, to the thickness of writing paper, the components form a covering, which is vitrified by baking. From the pegs the vessel is placed in a sagger, and at a lower heat of the oven the whole glaze is fused.

The following are excellent glazes:

For PORCELAIN.—Pulverize well, and carefully fuse together, flint 20 parts, cullet 7, Cornish-stone 20, red lead 20, borax 20, subcarbonate of soda 7, nitrate of potash 3, oxide of tin 2½, cobalt calx 1. *Or*,

Fuse together, flint glass 66 parts, red lead 15, arsenic 7, muriate of soda 5, nitrate of potash 6, cobalt calx 1. When well ground, mix with Cornish-stone 40 parts, frit (as above) 18 parts, flint 12 parts, and white lead 30; grind in the glaze, mill, and use carefully.

Fuse together Cornish-stone 80 parts, soda 20; pulverise, and grind together, for use.—The fritt 40 parts, flint 16, Cornish-stone 24, and white-lead 20.

Fuse together, cullet 85 parts, flint 10, white-lead 2, arsenic 1, nitrate of potash 2; then grind together, fritt 30 parts, Cornish-stone 40, flint 25, boracic acid 5.

The felspar glazes are subjoined for general purposes of utility. They are most secretly preserved by their first employers, but I wish them to be extensively known.

Fuse together, felspar 66 parts, borate of soda 34; then grind, and mix with flint 95, nitrate of potash 5, ground for use.

*Or*, felspar 60, borax 40, fused, and mixed with flint 50, potash 2.

*Or*, felspar 90, carb. barytes 7, lime 2, magnesia 1; and mixed with flint 67, borax 30, and potash 3.

*Or*, felspar 60, borax 24, nitre 6, salt 4, and potash 6, mixed with flint 60.

*Raw glazes*.—White-lead 45, Cornish-stone 22, cullet 22, flint 8, borax 2, salt 1.

*Or*, White-lead 51, Cornish-stone 25, Cullet 11, flint 12, carb. potash 1.

*Or*, White-lead 49, Cornish-stone 24, cullet 10, flint 14, borax 3.

*Or*, White-lead 42, Cornish-stone 27, cullet 14, flint 11, bor. acid 6.

*Iron-stone* glaze. Fuse together, Cornish-stone 36 parts, red-lead 12, flint 20, borate of soda 30, oxide of tin 2;

grind well, and add flint 35, Cornish-stone 40, and white-lead 25.

*Or*, Cullet 50 parts, Cornish-stone 25, flint 18, borax 7: fuse together, grind and use. Fritt 60, white-lead 40.

For *Blue Printed Ware.*—Earthenware or porcelain. Grind well together for use.

1. Cornish-stone 16, white-lead 40, cullet 8, flint 8, fritt (No. 4) 28.

2. Cornish-stone 20, white-lead 40, cullet 10, flint 10, fritt 20.

3. Cornish-stone 30, white-lead 40, cullet 18, flint 12.

4. Fuse together, and grind for use, red-lead 18, flint 30, Cornish-stone 20, borax 25, soda 4, tin 3.

*Chalk Bodies.*—Fuse together, Cornish-stone 40 parts, borax 24, soda 14, red-lead 22, grind; and add, ground together, Cornish-stone 40 parts, flint 20, and white-lead 20.

*Or*, Fuse together, Cornish-stone 32, flint 20, red-lead 15, borax 25, soda 4, tin oxide 4; grind well, and use with white-lead 20 parts.

*Cream-Colour Glaze.*—Grind together, for use, Cornish-stone 30, flint 9, nitre 3, cullet 10, borax 22, white-lead 26.

*Or*, Cornish-stone 36, flint 12, cullet 14, and white-lead 38.

*Or*, Litharge 45, Cornish-stone 30, cullet 10, flint 15.

*Or*, White-lead 50, Cornish-stone 26, cullet 8, flint 12, fritt (No. 4) 4.

Glaze for *Blue, and green, edged ware.*—Litharge 44 parts, Cornish-stone 24, cullet 12, flint 12, fritt (No. 4) 8. Grind well.

*Or*, White-lead 50, Cornish-stone 25, fritt (No. 3) 5, cullet 8, flint 12.

*Or*, White-lead 50, Cornish-stone 34, flint 12, cullet 4.

*Brown Lined Ware.*—White-lead 50, Cornish-stone 40, flint 8, cullet 1, borax 1.

*Green Glazes.*—Grind together, after being fused, sulphate of copper 60 parts, flint 20, and cullet 20; then use with litharge 40, flint 30, Cornish-stone 20, and fritt (No. 4) 10.

*Or*, Oxide of copper 28 parts, flint 22, cullet 18, white-lead 32; and use with 5 parts of blue printed glaze to 1 of the fritt, ground.

GLAUBER'S SALT, is sulphate of soda, and is found in efflorescence, in connection with sea-salt and rock-salt.

GLAUBER and EPSOM SALTS.—Glauber salts have been considered a more tonic aperient than Epsom salts. This is accounted for by the presence of a little iron in the one, and the absence of it in the other. According to the experiments of Dr. Davy, out of six different specimens of glauber salts, five were found to contain a small quantity of iron. Epsom salts may be made a tonic, by the addition of a very minute portion of iron.

GLUCINUM, from its oxide, a powder of emerald.

GLUTEN, is the insoluble residue of well-washed dough. It is purified by boiling in alcohol, till it cools quite clear, and what does not dissolve is albumen.

GOATS, have lately been recommended as a milk-giving animal. It is a cleanly docile animal, that supplies the finest milk two or three times a day, and brings two kids at a time.

GODFREY'S CORDIAL.—In three pints of alcohol mix two oz. of ground ginger, and also of Venice treacle, with six drs. of oil of sassafras; also mix four pints of thebaic tincture, (or white wine four pints, cloves and cinnamon each seven drs., and opium eight oz.) and 14 lbs. of treacle, with three gallons of water. Mix both liquids, and keep for use. *Or*, infuse one pound of caraway, coriander, and aniseeds each, in water, to distil off, four gallons, into which mix four pints of alcohol solution, with one ounce of oil of sassafras, and three oz. of opium; put the whole, with 21 lbs. of treacle, into five quarts of alcohol.

*Or*, in 8 galls. of water mix 56 lbs. of treacle and one gallon of alcohol, to which add eight ounces of opium, and five ounces of oil of sassafras, and oil of caraways.

GODFREY'S SMELLING SALTS, are obtained by resubliming subcarbonate of ammonia with pearl-ash, and some rectified spirit.

GOLD, is the only metal which has a yellow colour. It is the most malleable of the metals, and it is exceedingly soft and flexible, but its tenacity is sufficiently great to sustain, in a wire one-tenth of an inch in diameter, 500 lbs. weight without breaking. Its specific gravity is 19·3. In hardness, it is above lead and tin, but inferior to iron, copper, platina, and silver. Its lustre does not equal that of steel, platina, or silver. It may be exposed for any length of time to the atmosphere, without suffering the least change. It is also equally unalterable in fire; but, on being exposed to powerful burning mirrors, or to the heat of the oxy-hydrogen blow-pipe, it melts, and even rises in vapour.

Its only solvent is nitro-muriatic acid.

Gold is precipitated from its solution in aqua regia, or nitro-muriatic acid, by lime, magnesia, potash, or alkalies, as a yellow powder. Gallic acid as a red powder. Ammonia, or sal-ammoniac, as yellow and detonating, or fulminating powder, very sensitive and dangerous; but sulphur, oils, and ether absorb the ammonia, and destroy its fulminating power. It is also precipitated by sulphurets, by iron, lead, copper, silver, bismuth, tin, zinc, mercury, ether, and oils. Tin produces a precipitate of the purple powder of cassius, if a plate of it be immersed in the solution. Copper and sulphate of iron alone precipitate it as pure metal. Iron and gold are harder than steel.

Gold is found, native or mixed, with silver or copper. Melting frees it from copper, but from silver it is necessary to dissolve it in aqua regia, and precipitate the gold with sulphate of iron. The solution is poisonous. Two atoms may be combined with one, or with three of oxygen. An alloy of arsenic or antimony makes gold brittle, and less so with nickel, tin, zinc, cobalt, lead, and bismuth; iron, manganese, silver, and copper, increase its ductility. The gold coin is one-thirteenth of copper, or of copper and silver.

*Native gold* is found crystallized in the forms of the octahedron, the cube and the dodecahedron, of which the cube is considered as the primary form. It also occurs in filiform, capillary, and arborescent shapes; as, likewise, in leaves or membranes, and rolled masses. It offers no indications of internal structure, but, on being separated by mechanical violence, exhibits a hackly fracture. Its colour comprises various shades of gold yellow. Its specific gravity varies from 14·8 to 19·2. It is commonly alloyed by copper, silver, and iron, in very small proportion. Native gold exists in veins in primitive mountains, but not in the greatest quantity in those which are esteemed to be of the oldest formation. Its immediate gangue is generally quartz; and it is associated with the ores of silver, sulphuret of iron, lead, nickel, copper, &c. It is often so minutely disseminated, that its presence is detected only by pounding and washing the rocks in which it exists. But native gold is more often found in the sand of rivers, in valleys and plains, into which it has been carried from its original repositories, in the shape of larger or smaller, generally flat pebbles, mingled with quartz.

Native metals are seldom pure, and, even when reduced by ordinary means, some traces of admixture are to be found. Thus, gold very frequently contains silver; and, on the contrary, silver gold, and so on; but if the gold in a silver ore be in too minute proportion to repay the cost of separation, it is left; and so likewise when silver occurs in gold, in lead, &c. The possibility of this separation is nothing new; the profitable application of the knowledge is the only novelty, and this depends on the substitution of sulphuric for nitric acid in the process, and on the cheapness at which the former can now be made. The mode of procedure is as follows: add to the gold, from which the silver is to be extracted, two or three parts of silver, (for, without such addition, the silver would be protected from the action of the acid,) fuse, and granulate, by pouring the molten metal into water: then boil in sulphuric acid, and, during ebullition, oxygen from the sulphuric acid will convert the silver into an oxide, sulphurous acid in a gaseous form escaping while the gold remains unaltered; the oxide of silver which is held in solution is subsequently by immersing plates of copper, precipitated in a metallic form: it is pure, and only requires melting, and is technically known as water silver. The sulphate of copper, the refuse of this operation, is a merchantable article, and the sulphurous acid gas may be again converted into sulphuric; so that, if economically performed, nothing need be lost. The process, for the separation of gold, is a counterpart of that for the separation of silver.

Ether, naphtha, and essential oils, take gold from its solvent, and form liquors, which have been called *potable gold*. The gold which is precipitated on the evaporation of these fluids, or by the addition of sulphate of iron to the solution of gold, is of the utmost purity.

A variety of means are employed to judge of the quality of alloys, supposed to consist in part, or principally, of gold, without resorting to a regular analysis. The most common of these, consists in the use of the *touch-stone*. A mark is made upon the stone with the alloy, upon which a drop of nitric acid is placed by means of a feather: if the metallic streak disappears, the alloy is destitute of gold; if visible only in little points, at distant intervals, it indicates a small proportion of this metal; whereas, if the continuity and density of the mark remain unbroken, it evinces that the piece on trial is pure gold. This test is obviously founded upon the property possessed by gold, of being insoluble in nitric acid, while silver, copper, and their alloys, with zinc, are instantly taken up by this solvent. If the gold to be made use of appears to contain copper, (which is inferred from its reddish tinge,) it is made to undergo cupellation with a given quantity of pure lead; by which means the copper quits its union with the gold, and unites with the lead, leaving the former by itself, and, in this way, the proportion of gold in the alloy is ascertained.

If silver is presumed to be the alloying metal, the operation consists in melting the alloy with three times its weight of silver, rolling the compound into thin sheets, forming these into coils, and plunging them into nitric acid, slightly diluted: the silver is promptly dissolved, while the gold remains unaffected. This operation is called *quartation*, and the separation of the silver by nitric acid, *parting*.

In the English Mint, *gold* is melted in black-lead pots, and foreign pots are preferred, as containing less clay. These are placed in a furnace of 14 inches, and 20 deep, on a stand, usually a broken pot strewed with coke. They are covered with an inverted pot as a muffle, and heated to redness, with charcoal and coke. When hot the gold and alloy are inserted, and 6 or 7 ingots of 15 lbs. each, and 1-11th alloy are melted in an hour, but before withdrawn, the mixed metal is stirred with a red-hot rod of black lead. On being withdrawn by tongs which embrace it, the gold is cast into plates of 70 cubic inches, *i. e.* 10 long, 7 wide, and 1 thick.

In the English mint, the lb. of standard silver of 240 dwts. is made of 222 dwts. of fine silver, and 18 of alloy, *i. e.* as 12·333 to 1. The castings are made by an air-furnace in iron pots, which hold a charge of from 8 to 10 ingots of 60 or 50 lbs., and the moulds are of cast iron. The pots are covered with a muffle, and with ignited coke and charcoal, and in two hours are at a red-heat fit for the charge, before which fine charcoal is spread over the inner surface; while melting, other charcoal is thrown on the surface to prevent oxydation, and secure the alloy. To pour out the melted metal into the cast-iron moulds from so large a pot, it is raised from the furnace by a crane, and turned into a frame, which is fixed to an arc of rackwork, and the same windlass turns this arc so as to incline the pot to any degree, while it brings the heated and oiled moulds under the stream of liquid. There are two cranes to eight furnaces, and three meltings per day at each furnace. The bars and plates, both of silver and gold, are flatted to the thickness of coin by a rolling mill, the silver hot, and the gold cold, just as iron is rolled in iron-foundries, and as copper is silvered at Birmingham and Sheffield. Steam power and progressive thinning effect what appears impracticable, when seen in bars, and in thin leaves.

The relative value of gold and silver is the ratio of their price per oz. Thus, 3*l.* 17*s.* 10½*d.* per oz. of gold, and 5*s.* 2*d.* for silver, is 15 to 1, very nearly; *i.e.* in money, a man ought to receive for 1 lb. of gold 15 lbs. of silver. The ratio, of course, varies with the market-price per oz.

GOLD-BEATING.—The malleability and extreme divisibility of gold are the foundation of the art of *gold-beating*. In consequence of the wonderful extension which the gold-beater is enabled to give to this precious metal, it is employed for ornamental purposes to an extent which, from its comparative scarcity, would otherwise be impossible. Thus, it is estimated that an equestrian statue, of the natural size, may be gilded with a piece of gold not exceeding in value 12*s*. The gilding of the dome of the *Hôtel des Invalids* at Paris cost but £3500. And in India, where it is common to gild towers, bridges, gates, and colossal idols, it is known to be attended with still less expense. In *gold-beating*, the gold used is as pure as possible, and the operation is commenced with masses weighing about two oz. These are beaten into plates six or eight inches long, by three quarters of an inch wide. They are then passed between steel rollers, till they become as thin as paper. Each one of these is now cut into 150 pieces, and forged on an anvil till it is about an inch square, after which they are well annealed. Each of the squares in this state weighs 6·4 grs., and in thickness is equal to 1-766th of an inch. The 150 plates of gold, thus produced from one mass, are interlaid with pieces of very fine vellum, about four inches square, and about 20 vellum leaves are placed on the outsides; the whole is then put into a case of parchment, over which is drawn another similar case, so that the packet is kept close and tight on all sides. It is now laid on a smooth block of marble, and the workman begins the beating with a round-faced hammer, of 16 lbs.; the packet is turned, occasionally, upside down, and beaten with strong strokes, till the gold is extended nearly to an equality with the vellum leaves. The packet is then taken to pieces, and each leaf of gold is divided into four with a steel knife. The 600 pieces, thus produced, are interlaid with pieces of animal membrane, from the intestines of the ox, of the same dimension, and in the same manner as the vellum. The beating is continued, but with a lighter hammer, about 12 lbs., till the gold is brought to the same dimensions as the interposed membrane. It is now again divided into four, by means of a piece of cane, cut to an edge. The 2400 leaves hence resulting are parted into three packets, with interposed membrane as before, and beaten with the *finishing*, or *gold hammer*. The packets are now taken to pieces, and the gold leaves, by means of a cane instrument and the breath, are laid flat on a cushion of leather, and cut, one by one, to an even square, by a cane frame; they are lastly laid in books of 25 leaves each, the paper of which is previously smoothed, and rubbed with red bole, to prevent them from adhering.

GOLD WIRE is, in fact, only silver wire gilt, and is prepared in the following manner. A solid cylinder of fine silver, weighing abont 20 lbs., is covered with thick leaves of gold, which are made to adhere inseparably to it, by means of the burnisher: successive laminæ are thus applied, till the quantity of gold amounts to 100 grs. for every lb. troy of silver. This gilt silver rod is then drawn successively through holes made in a strong steel plate, till it is reduced to the size of a thick quill, care being taken to anneal it accurately after each operation. The succeeding process is similar to the former, except that a mixed metal, somewhat softer than steel, is employed for the drawing-plates, in order to prevent the gilding from being stripped off; and no further annealing is requisite after, if it is brought to be as slender as a crow-quill. When the wire is spun as thin as is necessary, it is wound on a hollow copper bobbin, and carefully annealed by a very gentle heat: finally, it is passed through a flatting-mill, and the process is complete.

GOLD THREAD.—The gold thread commonly used in embroidery consists of threads of yellow silk, covered by flattened gilt wire, closely wound upon them by machinery.

*Crystallization of gold.*—A small glass-stoppered vial, containing a solution of gold in a mixture of nitric and muriatic acids, had stood neglected for a considerable time, (perhaps four or five years) in a cupboard. Upon accidentally examining it, I found a portion of the acid had escaped, and the gold crystallized. This effect had probably been promoted by a flaw in the vial, which extended through the neck, and a little way down its length. The stopper in consequence must have been slightly loosened, and thus allowed more space for the formation of a thin dendritic crystallization of the gold. This was further continued down the inner surface of the vial, and was there sufficiently thick to admit the impresssion of minute, but distinct crystalline facets. A small crystallized lump of gold lay at the bottom of the vial; but I believe this had been originally attached to the rest, and merely by its weight, as I have since observed to be the case in another portion. Around the stopper, and along the flaw, there was a saline concretion, which tasted like sal-ammoniac, and as ammonia was kept in the same cupboard, it had probably united with the muriatic acid as it exuded. Upon finding this specimen, I examined some other metallic solutions, and found a similar separation of the metal had taken place in a vial containing a solution of platina, and in another, containing a solution of palladium. In both these cases, a thin, interrupted, and dendritic lamina of metal might be seen between the stopper and the neck; but the crystallization had proceeded no further. I unstoppered the vial containing the platina, and the lamina (as might have been expected) immediately disappeared in the form of a slight muddy film. The palladium I still possess. These facts, if multiplied, may, perhaps, serve to throw some light upon the mode in which the dendritic laminæ of native gold, silver, &c. are formed in rocks.—*Henslow.*

GOLDBOLD'S VEGETABLE BALSAM, as appears by the patent, professed to consist of the distillation of 42 several vegetables, besides five or six gums, vinegar, spirits of wine, and oil of cinnamon; all to lie in combination for three years.

GOLDEN NUMBER, a chronological element, found for any year, by adding 1 to the date, and dividing by 19. The remainder is the golden number.

GOLDEN OINTMENT, is the sulphuret of arsenic, called orpiment, mixed with spermaceti ointment, sometimes called Singleton's eye-salve, and, next to washing with soap and water, the best remedy for inflamed eyes or eye-lids.

GONG, a sort of Chinese bell, is four copper, one tin.

GOOSEBERRY WINE.—Take 40 pints of fully-ripe white or yellow gooseberries; bruise them well; add 20 pints of soft water, and 60 lbs. of loaf-sugar. Put them whole into any open vessel, stir them together, until the sugar be entirely dissolved. Let the whole ferment for a fortnight, and the refuse will separate. Then make a perforation or hole within two inches of the bottom; draw off the liquid, which you will find as pure as water. Put the liquid so drawn off into a cask large enough to admit of the spirits; and to every 20 pints of wine add three pints of the distilled spirit or brandy. Let it stand in the cask for five or six months, then bottle it; and, in half a year, you will find it similar to Mosellas, and far preferable to many of the sweet made-wines.—*Gardener's Magazine.*

GOSSAMER, is caused by an infinite multitude of small spiders, which, when they want to change their place, have a power of shooting forth several long threads, to which they attach themselves, and thus becoming buoyant, are carried gently through the air as long as they please; after which, by coiling up their threads, they descend very gradually to the ground.

GOVERNOR, is an ingenious piece of mechanism for regulating the moving power of machinery. In steam-engines, it consists of two balls, revolved by the machinery, whose circle of revolution is increased, if the machine goes too fast, and the rods which support them are connected with a lever at the top of their axis, which lever falls as the balls expand, and thereby shuts off the steam; but, if the balls fall from too little motion, the lever is forced up, and the steam-valves enlarged.

In a water-wheel, the principle of action of the governor is the same, but the effect is produced on an iron cross, or otherwise, which raises or depresses a sluice-board, so that, as required, the water falling on the wheel is increased or diminished in quantity.

In windmills, the governor, or life-tenter, to correct the effect of gusts of wind, consists of four balls or pendulums, or often of only one, which, with slight variation of form, acts on a lever which acts on the upper stone, and raises or depresses it, so as to increase or decrease the flow of the grain, from the eye in the centre.

In horse or hand-machinery, governors are not required, the power being within controul, and uniform.

GRAIN, consists of wheat, barley, oats, peas, rye, beans, and rice. These are the staff of life to man and all graminivorous animals, and the chief articles of culture. They are treated severally under different heads, and farming. When it turns musty, it may be rendered sweet and sound by immersing it in boiling water, and letting it remain till the water becomes cold. The quantity of water must be double that of the corn to be purified. The must rarely penetrates through the husk, and, in the worst cases, does not extend to the flour. The bad grains swim, and are to be taken away.

Of Wheats, there are the following kinds: — *White Wheat*, *Red Wheat*, *Calbigia*, *Bearded Wheat*, *Spring Wheat*, *Cone Wheat*, *Square Gray Wheat*, *Egyptian Wheat*, *Polish Wheat*, *Brent Barley*, *Spelt Wheat*, *Cascola bianca*, and several other species, are cultivated for grinding into flour for bread, or other farinaceous food; the seeds, also, make starch, farro, and semolino.

The *Cascola bianca* makes very good bread, yet is cultivated principally for its brilliant slender straw, used in making Leghorn hats.

*Soojec*, *Semolino*, *Semola*, *Urena*, mostly made from red wheat, and imported from Italy, is the heart of the grain, remaining in granules like coarse sand, that resists the action of the mill, the stones being soft, blunt, and not set close.

*Farro*, usually made from spelt wheat, is steamed, dried, and pearled, as in making pearl-barley.

*Semoletta*, *Semola rarita*, is a smaller kind of pearled wheat, separated from the preceding by sifting. All are used for gruel and soups; the two latter for vermicelli and other Italian pastes.

*Bran* is mixed with fine white bread, to render it laxative, and a decoction of it is the common mash, used as a restorative and alterative for horses.

The Oats are, *White Oats*, *Black Oats*, *Naked Oats*, *Pill*, *Pilcorn*, *Spanish Oats*, are the grain used to feed horses; 14 lbs. by the day being the usual allowance, unless the oats are bruised, or wetted with salt-water, a great part passes through them unchanged, in which case they are completely digested.

*Grits*, used for making a heating stimulant gruel, are oats, cut in pieces, and the husks separated by a mill.

Of Barleys, there are *Barley*, *Spring Barley*, *Turkey Barley*, *Square Barley*, *Bere*, *Naked Barley*, *Black Barley*, *Barley Wheat*, *Full Barley*, *Six-sided-Barley*, *Bigg*, *Round Barley*, *Winter Barley*, *Greek Barley*, *Sprat Barley*, *Battledore Barley*, and *German Rice*. All of these are cultivated for making pearled barley or malt.

*Pearl Barley* is the seeds of spring barley, steamed to soften the skin, then dried, and ground in a mill, to separate the husk, except that lodged in the deep furrow of the seed. In *Scotch Pearl Barley*, the seeds are ground smaller than the last into spherical granules, generally made from bigg or bere. All these pearl barleys make a cooling gruel, thicken soups, and are ingredients in pectoral and anti-febrile drinks.

*Malt* is made from barley, soaked in water, till it turns reddish, then drained, spread from one to two feet thick on a floor, where it heats, and emits its root or spike. It is then spread thinner for two or three days, again heaped up until it heats, and finally dried on a kiln, and the roots separated by screening. 5 lbs. of spring barley produce about 4 of malt. Malt is used to make an alterative analeptic infusion, and its decoction is fermented to form beer and ale.

*Grains* are the exhausted malt, left from brewing, used as food for pigs and cows, whose milk it peculiarly flavours, and renders putrescent.

*Rye* and *Spring Rye* have their seeds malted and manufactured into rye-spirit, and are also ground to flour.

*Spurred Rye* is diseased grains of rye, which, ground with healthy rye, and made into bread, causes gangrene of the limbs. It is now used as emmenagogue, in small doses; and to accelerate the contraction of the womb in protracted labour, and passive uterine hæmorrhage. The dose is 10 to 15 grs.

in powder, every 10 minutes, or as an infusion.

In *Maize*, *Indian Corn*, or *Turkey Corn*, the young ears are roasted for food, and the ripe grain made into flour, for biscuit-makers.

*Indian Rice.* Seeds, *rough rice*, *dahn*, *paddy*, used to feed birds. Arrack spirit is distilled from it. Husked seeds, *rice*, boiled for food, and to make an astringent decoction. *Ground rice*, used for puddings.

*Millet*, Husked seeds, used to make gruel, also ground flour.

The GRASSES are, *Indian Corn.* Seeds size of a mustard-seed, dark-coloured, fine-flavoured, made into milk gruel, or ground into flour.

*Spring Grass* nearly resembles camels' hay and Indian nard; a dried herb, used as a substitute for tea: the very agreeable odour of new hay is owing to this grass; root aromanic. 12 lbs. of hay, or at most 14 lbs. is the full quantity that ought to be allowed to a horse daily that works regularly and moderately.

*Flote Grass.*—Husked seeds, *Russia seeds*, *manna seeds*, nutritive, sweet, eaten.

*Reed Grass.*—Roots diuretic and emmenagogue.

*Canary Grass.*—Juice of the herb drank in pain of the bladder: seed used to feed small birds, and ground to make flour-paste.

*Lemon Grass*, *camels' hay.*—Stalk and leaves aromatic, sharp-tasted, heating, attenuant, discussive, tonic; contains a resin analogous to myrrh.

*Ginger Grass.*—An essential oil is distilled from it.

*Indian Spikenard.*—Bitter, smells like cyperus, and has the qualities of camels' hay.

*Drank*, *wild oat grass.* Seed drying, corrects stinking breath; decoction vermifuge.

GOULARD'S EXTRACT, sub-acetate of lead, or extract of satan, is one part acid, and three oxide of lead. It is also sold as virgin's milk, when one-third is combined with alum.

*Goulard's Ointment.*—Mix together, one drachm of camphor, and one and a half ounces of solution of acetate of lead, which add to, melted, four ounces of white wax, and nine ounces of olive-oil.

GOURDS, EDIBLE.—The cheese-gourd, some of which have weighed one cwt., and the vegetable marrow are to be preferred; but much more importance arises from the kind of cookery, than to the variety. *To make Cheese Gourd Soup.*—Take the fleshy part of the gourd when ripe, and cut it into small pieces; put it into a pan with a small bit of butter, set it upon a slow fire, until it melts down to a puré; then add milk, in the proportion of half a gallon to four lbs. of gourd; let it boil a short time, with a little salt and sugar, enough to make it taste a little sweet; then cut some slices of bread very thin, toast it very well, and cut them into small dice; put them in a dish, and pour the puré over, and serve it up.

GOWLAND'S LOTION, is a solution of corrosive sublimate in an emulsion of bitter almonds. Another cosmetic is the same in spirits of rosemary.—*Paris.*

GRAINS OF PARADISE, *Guinea grains*, are aromatic, stimulant, taste very hot, and biting like pepper. It is used by some in large doses, to cure agues, and also to give a false strength to wine, beer, vinegar, and other liquors.

GRAMINEÆ, have nutritive seeds, and are the basis of bread, and the most usual food of man and several animals. Most of them are wholesome; a few are aromatic, and the bran of most contains an acrid rosin, removed by the seeds being husked, or pearled, by steaming, dried, and ground in mills. The stems contain a saccharine juice.

GRANITE, is considered as the foundation rock of the globe, or that upon which all secondary rocks repose. From its great relative depth, it is not often met with, except in Alpine situations, where it presents the appearance of having broken through the more superficial strata of the earth, the beds of other rocks in the vicinity rising towards it at increasing angles of elevation as they approach it. It is composed of three minerals, viz., quartz, feldspar, and mica, which are more or less perfectly crystallized and closely united together.

The three constituents of granite are as under, taking their mean:

| | *Feldspar.* | *Quartz.* | *Mica.* |
|---|---|---|---|
| Silica ........ | 64 | 96 | 47 |
| Alumine...... | 19 | 2 | 22 |
| Lime ........ | 2 | 2 | |
| Potash ....... | 13 | 0 | 14·5 |
| Iron, (oxide). | 1 | 0 | 15 |
| Mang..(do.).. | 0 | 0 | 1·75 |

Granite has been divided into several sub-species, or varieties; of these, the following are the most important:—*Common granite*, in which the three ordinary constituents above-mentioned occur in nearly equal proportions; the feldspar may be white, red, or gray. *Porphyritic granite*, in which large crystals of feldspar are disseminated through a common granite, whose ingredients are fine grained. *Graphic granite*, which consists of feldspar in broad laminæ, penetrated perpendicularly with long imperfect crystals of quartz, whose transverse angular sections bear some resemblance to certain letters, especially to those of Oriental languages. *Sienite* or *sienitic granite*, in which hornblende, either wholly or in part, supplies the place of mica. *Talcky* or *chloritic granite* (the *protogine* of the French,) in which talc or chlorite takes the place of the mica. *Feldspathic granite*, in which feldspar is the principal ingredient.

The aspect of granitic mountains is extremely diverse, depending, in part, upon the nature of its stratification, and the degree of disintegration it has undergone. Where the beds are nearly horizontal, or where the granite, from the preponderance of feldspar, is soft and disintegrating, the summits are rounded and heavy. Where hard and soft granite are intermixed in the same mountain, the softer granite is disintegrated, and falls away, leaving the harder blocks and masses piled in confusion upon each other, like an immense mass of ruins. Where it is hard, and the beds are nearly vertical, it forms lofty pyramidal peaks or *aiguilles*, like the Aiguille de Duc and others, in the neighbourhood of Mont Blanc.

Granite forms some of the most lofty of the mountain-chains of the eastern continent. In Europe, the central part of the principal mountain-ranges is of this rock, as in Scandinavia, the Alps, the Pyrenees, and the Carpathian mountains. In Asia, granite forms a considerable part of the Uralian and Altaic ranges of mountains; and it appears, also, to compose the principal mountains that have been examined in Africa; whereas, in the western hemisphere, it has never been observed rising to such great elevations, or composing such extensive chains. It is, nevertheless, very abundantly distributed over the northern parts of the American continent, as in Labrador, the Canadas, and the New England States. In New Hampshire, it is the predominating rock of the White Mountains, in which it attains the elevation of more than 6000 feet. In the Andes, it has been observed at the height of 11,000, but is here generally covered by an immense mass of matter, ejected by ancient and recent eruptions.

Granite very frequently forms veins, shooting up into the superincumbent rocks, which seems to indicate that it has existed below in a state of fusion, the heat of which has softened and parted the upper rocks, and forced up the granite, in a melted state, into these fissures.

Granite abounds in crystallized earthy minerals; and these occur, for the most part, in those masses of it existing in veins. Of these minerals, beryl, garnet, and tourmaline, are the most abundant. It is not rich in metallic ores, though it contains the principal mines of tin, as well as small quantities of copper, iron, tungsten, bismuth, silver, columbium, and molybdenum.

Granite supplies durable materials for architecture and for decoration. It varies much in hardness, as well as in colour; accordingly, there is room for much care and taste in its selection.

GRANULATION; the method of dividing metallic substances into grains or small particles. This is done either by pouring the melted metal into water, or by agitating it in a box until the moment of congelation, at which instant it becomes converted into a powder.

GRAPES.—The method of training vines at Fontainbleau, where the famous grapes are produced that supply the Paris markets, consists in allowing the plants very little room to grow either with their branches or their roots, and in keeping the latter very near the surface of the ground; each vine is only allowed to occupy a space of about six feet, so that the walls are supplied by a multitude of plants.

The error in growing grapes in Britain consists in training them into elevations. They ripen best when trained near the ground, in open air. The heat of hot-houses is an exception. Vineyards, in France, resemble plantations of gooseberry-bushes, with the bunches close to the soil, the heat of which ripens them.

Grape Wine.—Take water 4¼ galls., grapes 5 galls. crushed and soaked in the water 7 days, sugar 17½ lbs. The cask in which it was made held exactly 6¾ galls. and produced 34 bottles of wine clear. A bottle kept 10 years proved very good.

*To preserve Grapes.*—Take a well-bound cask, from which the head is to be removed, and place at the bottom a a good layer of bran. On this place a layer of grapes, then bran and grapes alternately until the cask is full. Put on the head, which is to be cemented, and the grapes will keep for a year. When used, in order to restore their freshness, fresh cut the stalk of each bunch and place it in wine, as flowers are placed in water.

GRASS, is the union, in spring, of 11 species of natural grasses in one pasture; in summer of 11 other species, and in autumn of 3 others, fiorin, yarrow, and couch. Certain weeds and flowers, also, mingle in small quantities, as butter-cups, burnet, sorrel, dock, &c. Some species prevail in particular soils, but the most general in all, is cocksfoot, meadow-fescue, crested dogs'-tail, hand-fescue, sweet-scented vernal, rye, (grasses,) and upright brome. The meadow fox-tail and oat-grasses, also, prevail in some pastures. A turf of 1 foot square, in a rich pasture, contained 1090 separate plants of 20 species; but pastures of artificial rye-grass and clover contained but 75 in the foot. To produce a similar pasture by art, 15 bushels of seed would be required for 6 acres, of which cocksfoot, meadow-fescue, meadow-foxtail, and rough meadow, would be two bushels each. For sandy soil, 3 bushels and a peck would be required for an acre, of which cocksfoot and rye-grass would be $3\frac{1}{2}$ pecks each.

In the production of a rich pasture by sowing, 18 species are sown on rich soils, and 13 on sandy, so that there may be 5 or 10 seeds to every square inch. To the sorts named 1 bushel each of hard fuscue, crusted dogs'-tail, narrow-leaved wood-meadow, and perennial ray-grass, are added, and half a bushel of tall oat, nerved meadow, fiorin, cow-grass, and creeping vetch. But the seedsmen make up, at current prices, the due variety for all soils and all preparations of them. In two seasons a ploughed field is thus converted into a rich pasture, and as rich as we please; but the variety seems essential to all, and equally so to the animals which eat it.

There are machines for sowing grass seeds. By hand, each sort should be sowed separately, or well mixed. Windy and wet weather should be avoided. They should be well harrowed and rolled, after sowing, and heavily rolled in the following spring.

Of the 215 British grasses, experiments have been made on 97. In nutriment, tall fescue stands at the head. In quantity, timothy is greatest. And, in aftermath, the narrow-leaved meadow-grass is best.

But, after all, though we imitate natural grasses, they are not alike nutritive, wholesome, and agreeable, to cattle; hence, varieties have been adopted of which the whole is beneficial and in increased crops. They are red, crimson, and white clovers, sainfain, and lucern, principally; and, sometimes, tares, clover, and rye-grass. These are called cultivated or artificial grasses.

Permanent natural pastures are clays unfit for barley, soft clay loams, with clay bottom; rich vale land, the drain of other lands. Other pastures are more profitable under the rotation system. On old pastures, seven sheep per acre are fed in summer, and two in winter. They increase in weight from 80 ℔s. to 96 ℔s. each, besides their wool.

Near London, the grass lands manured every, or every other, October, yield about 2 tons, or 4480 ℔s. of hay; *i. e.* 80 trusses, or $2\frac{1}{4}$ loads, which sell in market for 10*l.* or 12*l.* The after-math and winter-feed is supposed to pay the expences, and about 5*l.* or 6*l.* is paid for the land. Sir John Sinclair says that if the same land, the same manure, and the same market, was in Scotland, it would be made to produce four times as much.

*Red Clover* follows deep ploughing for turnips, and it restores fertility for wheat crops. Sometimes cocks'-foot, timothy, and rye-grass, are mixed with it. It is food for stock, green on the soiling system. It should be cut for hay before the seeds are ripe, and the second crop will be heavier. It is not to be shaken like hay, but turned in the swath and cocked the same evening. In three or four days it may be stacked. The yield is two or three tons per acre, at a better price than hay. The second crop may have salt added in stacking.

*Cock's-foot* is deemed the most useful and advantageous of the grasses, except in low situations.

*Sainfoin* is adapted to poor and calcarious soils, and yields about two tons per acre, besides after-crop, and it grows for several years. It is sown in February with barley or buckwheat. It is equal, as food, to clover, but grows in worse situations.

*Lucern* requires a good soil, and may be drilled or cast between rows of barley, at 13 ℔s. to the acre. It affords three or four cuttings in the year, and is a great luxury to all cattle. It requires to be hand-hoed and scarified between the drills, and trenched with the spade, but it repays all expense.

The marsh trefoil has been employed as a wholesome substitute for hops.

After washing and drying, chemical analysis displayed, in the foot of 1090 plants, sand (silex and alumine) 160 in 400, oxide of iron 8, carbonate of lime or chalk 32, alumine or pure clay 25, silex, or earth of flints, 65. The rest moisture, &c. A second, equally rich, in another county, gave sand, &c. 148, oxide of iron 40, chalk 0, alumine 34, and silex 65.

A square foot of rich irrigated meadow displayed 1798 several plants.

For further particulars see the *Hortus Gramineus Woburnensis*, a barbarous *latin* name for a sensible account of plain *English* grasses.

In peats, with wet, the prevailing sorts are, sweet-scented, cocksfoot, meadow fescue, rough-stalked meadow foxtail, crusted dogs'-tail, &c.

The rough-stalked meadow is that which is preferred by poultry and birds.

In the United States the *dactylis glomerata* is preferred for dry land, the *agrostis stricta* for wet land, and the *phleum pratense* for clayey soils.

GRATES.—The best shape, and that which requires less coal at any one time, is in the proportions of 12 inches deep to 8 inches square at the top, and gradually diminished to 6 inches at the bottom, which the heat generated in the combustion of the coal at the lower part of the grate, in its passage to escape into the chimney, comes in contact with nearly the whole body of coal. The Romford grate is also generally preferred, for its economy and heat.

GRAVEL WALKS.—When a new walk is made, or an old one reformed, take the necessary quantity of road scraping, previously dried in the air, and reduced as fine as possible; mix with the heap enough of coal-tar from a gas-work, so that the whole shall be sufficiently saturated, and then add a quantity of gravel: with this lay a thick stratum as a foundation, and then cover it with a thin coating of gravel, well rolled.

GRAVIMETER, is a modern French name for an hydrometer, as applied to both solids and liquids.

GREASE, or OIL SPOTS, on paper, are removed by a weak solution of potash; and ink-spots by chlorine. And both, as well as dirt, are removed from prints, &c. by immersing them in a vessel of chlorine gas.—*Or*, Take the yolk of an egg and put a little of it on the spot, then place over it a piece of white linen, and wet it with boiling water: rub the linen with the hand, and repeat the process three or four times, and at each time apply fresh boiling water. The part is then to be washed with cold water.—*Or*, mix pyroligneous ether 1 oz. with essence of lemon 3 drs. The parts should be well rubbed with tow, or a piece of woollen cloth, moistened with this composition.

GREENOUGH'S TINCTURE FOR THE TEETH.—In 2 pints of alcohol infuse 4 drs. of spirit of scurvy grass, 2 oz. of bitter almonds, 4 drs. of brasil wood, baccharis, and cassada, 2 drs. of Florentine iris, and 1 dr. each of alum, verjuice, salt of sorrel, and cochineal.—*Or*, (*Ruspini's.*) In 2 pints of alcohol infuse 1 oz. of essence of ambergris, 8 oz. of Florentine iris-root, and 1 oz. of cloves.—*Or*, (*Hudson's Preservative of the Teeth and Gums.* Mix 3 oz. each of myrrh and Peruvian bark tinctures, and cinnamon-water, with eau d'arquebusade 1 oz., and ½ oz. of powdered gum arabic.

GREEN, PRUSSIAN, is the sediment of the two first processes for making *Prussian blue*, before the muriatic acid is added; or it may be made by pouring oxymuriatic acid upon fresh precipitated Prussian blue.

GREYWACKE, a German word of three syllables, which imports a formation of distinct pieces of quartz, hard slate, and feldspar, combined in a bed of clay slate. But when the pieces are granulated in the clay slate, it is then called Greywacke slate. It contains early shells though a transition rock; also transition limestone and trap, with many ores and veins. Since its formation there must have been at least 12 revolutions of the perihelion.

GOUT, a disease resulting from eating animal food and drinking fermented liquors, either by patients or their parents. Hence it, and the gravel and stone, are diseases of wealth and excess of costly diet. Wollaston analysed the chalky concretions which appear in the joints, and found that they consist of Uric acid and ammonia, which are the exact constituents of stone in the bladder. By the Uric, or lithic acid, the concretions of gout and of stone may be exactly imitated; and Scheele found that the stones of a woody appearance were almost wholly composed of this acid. It is found in all human urine; but its excess leads to the formation of chalk stones and calculi. As these frightful diseases are peculiar to the human race, Wollaston and others ascribe them to those peculiarities of human subsistence—cooked animal food and fermented liquors, to both which other animals are strangers.

GROINS, walls on the sea-beach, constructed so as to obstruct and accumulate the stones and shingle, drifted by the tide. They are made of stout uprights, driven into the sand, with intervening planks of stout oak. They protect the beech and cliffs in a very effectual manner.

GROUNDSEL.—A weak infusion is a common purge. A strong infusion, or the juice, is used as an emetic. It is also given to horses to free them from botts. The flowers are given to song-birds as a cooler.

GROUTING, is the pouring of liquid mortar on a course of bricks before the next course is laid, so as to fill up all the interstices between the bricks.

GUAGING, is the very simple art of determining the contents of any vessel in gallons and parts. Every gallon is 277·274 cubic inches. A barrel of 36 gallons is, therefore, 9981·87 cubic inches, and is such a bulk that it corresponds with a cube of 21·53135 inches in each dimension.

A kilderkin is half, or 4990·935 cubical inches, such that it is equal to a cube of 17.09 inches each way.

In guaging, it is usual to determine a mean diameter, and this is nearly the half the diameter of the bung and head. But a closer approximation is made, by adding double the square of the bung diameter to the square of the head diameter, and then multiplying the sum by the clear length, and dividing by 1059 for imperial gallons.

We used to divide by 1077 for ale gallons, and 882 for wine gallons; but all business is now done in the imperial gallon of 277·274 cubic inches, and 1059 is the true divisor.

If then a cask is 20 inches at the bung diameter, and 17 inches at the head and 38 inches long, the square of 20 is 400, and twice is 800. The square of 17 is 289. Their sum is 1089. This, by 38, is 41382, which, divided by 1059, gives 39 gallons and the 13th.

If it had been a cylinder, as a tub, or circular vat, half the top and bottom diameters would be a mean diameter. Then this, squared and multiplied by 0·7854, would be the area of the mean diameter. This, unto the height, would be the number of cubic inches, and this divided by 277·274 would be the gallons.

If a square ton, the length and breadth by the beigth, divided by 277·274, is the gallons, and this again, by 36, is the barrels.

If we want it in cubic feet, we divide by 1728, the number of cubic inches in a foot.

If we want the weight, we multiply the gallons by 10 for lbs. if water, and by 11 if strong beer, or by 99 if spirits.

If we have barrels of 36 gallons old measure, or 282 cubic inches, to convert into imperial measure of 277·274 cubic inches, we multiply 36 by 282 and divide by 277·274.

If we have a wine hogshead of 63 wine gallons of 231 cubic inches, we multiply 63 by 231, and divide by 277·274 for imperial gallons.

In the first instance, we might have multiplied 36 by 1·017045. In the second, 63 by 0.8331107. Those being the ratios to 1 of 282 to 277·274, and of 231 to 277·274.

In like manner, the old corn-gallon of 268·8 is, to the new of 277·274, as 0·96943 to 1, in guaging malt, &c.

GUDGEONS, are the ends of axles, on which they work and rest. In water-wheels they ought to be strong enough, but not so large as to increase friction unnecessarily. The proportions of wrought iron and cast iron are as 3 inches to $3\frac{1}{2}$ or 8 to $9\frac{1}{4}$.

To determine their diameter, extract the cube-root of the weight of the water-wheel, in hundred weights, and the root is the inches for the diameter in cast-iron; but if wrought-iron, it may be as 14 to 9 less. If it is a wooden axle, multiply the diameter in feet by the width in feet, and add half the square of the diameter; then the cube-root of this sum is the diameter of the fit gudgeon in inches. A gudgeon contains in cwts. the cube of its diameter in inches.

GUIACUM, is the resin or substance of a tree, whose wood so abounds with it that it is itself medicinal as a decoction; and both are much used as stimulants and cathartics, for promoting the action of the skin and urinary organs. In general, its dose is 10 grs. to $\frac{1}{2}$ dr. in pills, but 1 dr. operates as a cathartic.

GULPH WEED, *(Laver)* is eaten raw as a salad: also pickled as samphire. It is aperient, diuretic, and antiscorbutic. Large quantities are brought from Devonshire, and consumed in London as a luxury.

GUM, in its constituent resembles starch and sugar, being 42 carbon, 6 or 7 hydrogen, and 51 oxygen. It is soluble, glutinous, and mucilaginous; heated, it forms charcoal. It is decomposed by strong heat, and precipitated from water by alcohol. Boiled in sulp. acid and water, it forms sugar. There are several varieties of nearly similar properties.

Guérin has analysed several varieties of gum. *Arabin*, which constitutes the greater portion of gum arabic, is composed of

| | |
|---|---|
| Carbon - - - | 43·81 |
| Oxygen - - - | 49·85 |
| Hydrogen - - - | 6·20 |
| Azote - - - | 14 |
| | 100·00 |

Gum arabic is found to consist of

| | |
|---|---|
| Arabin - - - | 79·40 |
| Water - - - | 17·60 |
| Ashes - - - | 3·00 |
| | 100·00 |

Messrs. Gay-Lussac and Thenard found its composition to be:

| | |
|---|---|
| Arabin - - - | 84·16 |
| Water - - - | 13·43 |
| Ashes - - - | 2·41 |
| | 100·00 |

The difference of water found depended upon the different methods of analysis.

The dried root of the *blue-bell* contains mucilage, very similar to gum arabic.

*Gum senegal* is less soluble than gum arabic, and deeper in colour.

GUN. At the Royal Institution, Dr. Faraday lately produced a new gun. The principle consists in the introduction of the priming into the barrel, and firing it in that situation at the *top* of the powder. The priming being fixed in the wadding or shot cartridge, is struck by a fine steel pin, which passes through a sheath or tube, surrounded by the gunpowder; and the advantages are, that no operation of priming is required, that being done in the act of loading; there is no flash or smoke, it is perfectly water-proof, and not liable to miss-fire; and the whole charge of powder must be ignited in consequence of being fired from the top and exactly in the centre.

GUNPOWDER, is explosive nitre brought into intimate contact with inflammable sulphur and charcoal. 75 of the nitre, 16 of charcoal, and 9 of sulphur, pounded as paste with wooden mortars, fixed in a wheel for 12 hours. It is granulated by being forced through a sieve, and glazed by agitation in a cask. The gas formed by an explosion is 2 volumes of nitrogen to 1 carbonic acid.

Dr. Ure has analyzed various samples of gunpowder, and the following are the results of his investigations:—

Waltham Abbey, nitre 74·5, charcoal 14·4, sulphur 10·0, water 1·1.

Hall, Dartford, nitre 76·2, charcoal 14·0, sulphur 9·0, water 0·5.

Pigou and Wilks, nitre 77·4, charcoal 13·5, sulphur 8·5, water 0·6.

Curtis and Harvey, nitre 76·7, charcoal 12·5, sulphur 9·0, water 1·1.

Battle gunpowder, nitre 77·0, charcoal 13·5, sulphur 8·0, water 0·8.

Charcoal, sulphur, and nitre, being ready for manufacturing into gunpowder. 1st. They are separately ground to a fine powder, which is passed through proper silk sieves or bolting machines; 2d. They are mixed together in the proper proportions; 3d. The composition is then sent to the gunpowder mill, which consists of two edge-stones of a calcareous kind, turning by means of a horizontal shaft, on a bed-stone of the same nature; incapable of affording sparks by collision with steel. On this bed-stone, the composition is spread, and moistened with as small a quantity of water as will, in conjunction with the weight of the revolving stones, bring it into a proper body of *cake*, but by no means to a pasty state. The line of contact of the rolling edge-stone is constantly preceded by a hard copper scraper, which goes round with the wheel, regularly collecting the caking-mass, and bringing it into the track of the stone.

The materials for gunpowder are ground by a wheel revolving in a trough. They are then moistened and put into boxes with holes in the bottoms. The boxes are placed in a circular frame suspended by cords, and briskly agitated by a crank, when the paste passes through the holes as corns of powder. These are afterwards polished by being revolved in a barrel, dried by vessels of steam, and packed for sale.

Gunpowder to be good, should be quick, strong, free from impurity, and not liable to absorb moisture. The general method of trying the purity is by burning it on clean white paper: 2 or 3 small heaps are made near each other, and one of them is fired; if the smoke rises perpendicularly, and there be no feculent matter left on the paper, nor the other heaps fired, it is considered that the ingredients were of a good quality, and well compounded. If the other heaps are fired, the paper burnt, or a dirty residuum left, it may be supposed that the nitre was impure, or that the charcoal was not completely pulverized.

GUYOT'S SPIRIT, to preserve reptiles, vegetables, &c. From 5 gallons of French brandy, distil 10 pints; to the residue in the still, add 30 pints of spring water, and 1 lb. of lavender leaves or flowers, and distil as long as any thing comes over. Mix spring water 69 oz. (measured) with 11 oz. of the first, and 80 oz. of the second results, measured.

GYPSUM, is 42 lime, 56 sulp. acid with muriate of soda, or in crystals, as found in England, is 34 lime, 48 sulp. acid, and 18 water, but some have 30 acid, 32 lime, and 38 water.

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HAIR, is a species of vegetation which grows in the cellular membrane of all animals, except fishes and reptiles; in fact, in all warm-blooded animals. It originates in a cylindrical root, surrounded by a capsule, with nerves, &c. called a bulb, which is supported by a fluid in the membrane. Black hair consists of several principles, and red and white differ only in the colour of the oil in them. Baldness arises from the mortification of the root.

From the nature of the constituent principles of hair, Vauquelin thinks we may account for the various colours that distinguish it. According to him, the black colour will be owing to a black and as it were bituminous oil, and perhaps likewise to a combination of sulphur with iron. Carroty and flaxen hair will be occasioned by the presence of a red or yellow oil, which, when deepest, and mixed with a small quantity of brown oil, produces the dark red hair. Lastly, white hair is owing to the absence of the black oil and sulphuretted iron. He believes, that, in the carroty and flaxen, as well as in the white, there is always an excess of sulphur; since, on the application of white metallic oxides to them, such as those of mercury, lead, bismuth, &c. they grow black very speedily. The manner in which this substance acts on metallic bodies leads him to suspect, that it is combined with hydrogen.

In hair, exclusive of the animal matter that forms its basis, and which is the same in all, there is a colouring matter, that may be separated from it, and the hue of which varies according to the kind of hair of which it constitutes the distinction. To this fatty substance M. Vauquelin attributes the suppleness, elasticity, and unalterability, which exist in hair: to this substance too is owing, no doubt, the property it has of burning so rapidly, and that of forming soap abundantly with alkalis.

The epidermis, nails, horns, wool, and hair of beasts in general, are formed of the same animal mucus, and equally include in their composition a certain quantity of oil, which imparts to them the suppleness and elasticity they are known to possess.

HAMMER, an instrument of force, as its velocity and weight. Two feet long, with the arm two feet or radius four feet, by 6·283, gives a velocity of 25, which, at 12 strokes per minute, for returning and striking, affords a striking velocity of 600. The momentum is then as the weight, and at 6 lbs. 3600, or 12 lbs. 7200. The jar increases the effect, and heat, or atomic motion, and dispersion of atoms is the consequence.

The primary force of the arm is derived from reaction against the ground, and the power of reaction from gas fixing in the lungs.

In forges, tiltings-mills, and in cloth-milling, hammers are raised by plugs, or wipers, fixed in an axle, and depressing the opposite side of the fulcrum. The action is very rapid and effective; and in cloth-milling they are of wood. In iron-works the force is increased by a spring, which arrests the ascent and propels the returning stroke.

HAND-MILLS, to grind coffee, pepper, &c. are either of such ordinary kind as to require no description, or peculiar to makers and patentees, but too various for description. They are often used in families for flour, where rye, barley, or coarse wheaten bread is preferred.

HARDNESS, may be defined as that property of bodies by which they resist indentation. Chemists and others usually ascertain the comparative hardness of bodies by rubbing the one against the other; any angular prominence of a harder body being capable of scratching or making a mark upon the surface of a softer.

Kirwan has exhibited the hardness of the different species of stones, by the impression made on each other. In the following table the stones which stand first are able to scratch, or cut, the succeeding, but not vice versa; and such stones, the hardness of which does not exceed 11, may be scratched by steel.

| | |
|---|---|
| Diamond | 20 |
| Pink, &c. diamond | 19 |
| Ruby | 17 |
| Pale ruby | 16 |
| Deep blue sapphire | 16 |
| Topaz | 15 |
| Emerald | 12 |
| Garnet | 12 |
| Agate | 12 |
| Onyx | 12 |
| Amethyst | 11 |
| Crystal | 11 |
| Carnelian | 11 |
| Green jasper | 11 |
| Shoerl | 10 |
| Tourmaline | 10 |
| Quartz | 10 |
| Opal | 10 |
| Chrysolite | 10 |
| Fluor | 7 |
| Calcareous spar | 6 |
| Gypsum | 5 |
| Chalk | 3 |

HARTSHORN.—As stags shed their horns every year, the material is abundant, and it contains 27 gelatine in 100 parts. Hartshorn jelly is made by boiling 4 oz. of the shavings in a quart of water to a pint; and, when cool, it is a clear nutricious jelly, flavoured with lemon, sugar, and wine, or mixed with milk.

HEART, a hollow muscle, which is the centre of the circulating system of animals, and contains four cavities, two *auricles*, and two *ventricles*. It is wrapt in a membrane, called the *pericardium*. The right auricle has a communication with the right ventricle, which is closed when the heart contracts. It has also three openings, the inferior *vena cava*, the *superior*, and the coronary vein. The left auricle has a communication with the left ventricle. It has also four pulmonary veins and the orifice of the aorta. The coronary veins return the blood of the heart into the right auricle. The red blood flows from the lungs into the pulmonary veins and the left cavities of the heart, from which it passes into the aorta, and thence to the extremities in the arteries. It loses 2° of heat, and becomes black; but, passing through the veins and receiving the chyle and lymph, it is emptied into the right cavities of the heart. It then passes through the pulmonary artery to the capillary vessels of the lungs, where the oxygen of the inspired air restores it to its red colour for a new circuit. The two auricles contract and dilate simultaneously, and also the two ventricles; and the contraction is called *systole* and the dilatation *diastole*. The projection at each systole is about 2 oz. Fishes and reptiles have only a single heart of one auricle and one ventricle.

HEARTBURN LOZENGES. — Mix 4 oz. of prepared whiting, 2 oz. of prepared crabs' claws, 1 oz. of bole armoniac, 1 scr. of nutmeg, and 3 oz. of sugar, with water.—*Or*, Mix in mucilage of gum arabic 3 oz. of sugar, ½ oz. of cinnamon, 2 oz. of crabs' claws, and 4 oz. of whiting.

HEART-WHEEL, an elliptical wheel, used in cotton factories, and in coining, by which an alternating motion is communicated to a circular wheel, against which it rubs.

HATS, covering for the head, made of straw and chip; or by felting, of fur, silk, woollen, or cotton. The manufacture of different kinds employs many thousand hands, and those of silk are now generally preferred for men, and of straw for women. Leather caps are also much used on the Continent, and worsted caps by seamen. As nature has provided ample covering for the head, the lighter the covering the better; and Franks, and other London makers, now make men's silk hats which weigh but 4 or 5 oz. while straw hats are still lighter. They are made waterproof by a solution of caoutchouc. It has been proposed to make hats of the kookoree, or solah plant, the same that Chinese rice-paper is made of. Any material is more worthy than beavers' fur, and only half the expense.

HEAD, the bony case containing the brain, with the senses, in juxtaposition, for its guide and instruction. It is distinct and prominent in all vertebrated animals, less so in the cephalida, while the acephalda, as worms, &c. have no heads.

HEAT, is the motion of atoms, or the motion of such atoms as, in the union of various atoms, are themselves the most capable of being put into motion. Then, as different substances consist of more or less of these mobile atoms, so different substances have various powers of receiving and displaying heat. A disposition of philosophers to refer all effects to some occult quality of matter, instead of examining the mechanical actions and re-actions, induced those of the last age to assume that there were peculiar heat-making atoms which created heat by some quality of their own, and this heating fluid they called caloric! But it is now found that caloric is a gratuitous and imaginary principle, and that all the phenomena of heat may be explained by the motion of atoms present, and by their various susceptibilities from density or entanglement, of which heat is the mechanical measured effect, in its expansions, evaporations, separations, nervous sensations, &c.

*To produce Heat and Fire.*—1. Rub two pieces of dry wood together, with spicula near the place of contact, and in a few minutes they will smoke, and the spicula flame. A turning lathe will accelerate the effect.

2. Strike a nail on an anvil or firm surface, ten or twelve strokes in four or five seconds, and in the dark it will be seen red-hot; apply tinder to it or a match, and light and flame will be the result. A dry grindstone will increase the effect.

3. Place a piece of brass in a cylindrical trough of two or three gallons of water. Apply a boring apparatus to the brass, revolving with the usual velocity, and the water will rise gradually to the boiling pot.

4. Rub metals together in an exhausted receiver, and they will soon become intensely hot, proving that atomic motion alone is the heat.

5. Strike a flint and steel together, and particles of the steel will be rendered red-hot; and, falling on tinder, gunpowder, or any combustible, will produce fire and flame.

6. Prepare an air-tight cylinder, with a small orifice-pipe and cock in the side, and a tight piston to work in the top. Suddenly depress the piston to a third of the height of cylinder; let out the compressed air at the cock, and it will set fire to tinder, owing to the motion diffused in the whole being concentrated in the third.

7. Put drops of water on the piston, and, as it becomes hot, the drops of water will become steam, and attain an expansion such as the air lost by the depression of the piston; the previons expansion of the air being transferred to the drops of water.

8. Beat a piece of iron with a hammer, so as to raise its temperature; sprinkle water upon it, and while the water is expanded into steam, the temperature of the iron returns to its first state, the momenta of the hammer being then in the steam.

9. Light a small end of a candle and cover it close with an inverted tumbler. The light will go out in half a minute, and nothing else will burn or live under the tumbler.

10. Cover a small animal, as a mouse or kitten, with a large tumbler, and in a short time the animal will die, if the air is not renewed, and nothing will live or burn under the tumbler.

All which facts and experiments prove that heat is mere motion, or atomic momenta, concentrated and diffused with various displays in different bodies and circumstances. It is the motion of percussion or friction received by the atoms of the body; or it is the force of compression by which the previous atomic motion is imparted to bodies around. In fact, it is a law that the expansion of one body causes cold, or abstracts the motion from other bodies in its vicinity; and that the compression of one body causes heat by transferring its atomic motions to bodies in its vicinity.

There is no other heat but from this principle, and when a candle or a coal-fire burns, after receiving the first excitement, it is the condensation of the oxygen of the air by the hydrogen in the tallow or coals; that is, it is the principle of acidity, in a gaseous state, combining with the principle of alkalinity in its gaseous state, and, by their mutual compression, forming water, thereby diffusing their previous motion to other bodies in juxtaposition.

Nor ought we to lose sight of what happens to atoms of water, when made to expand by the motion or heat of any surface, from which they are raised or evolved, as steam. They rise by transferred motion into a space full of air, or of atoms of aerial gas. Their tendency is to move in right lines. But the space being already full, they are deflected from their right lines by continuous deflections, and a right line motion continually deflected necessarily becomes AN ORBIT. Hence all radiation begets orbits, and all gas is atoms, in orbits—arising from the continual deflections of right line motions. Gas is, therefore, a state of great atomic excitement and power; and, consequently, by its fixation in combustion, respiration, condensation, &c. is capable of transferring all its forces and powers in those processes. Its powers are, too, and also the space which it fills, is, of course, as the first excitement; and this, therefore, is the true principle of gaseous expansion and varied power of elasticity, in all gases. In space, generally, there is only the gas, and hence the permanency of primitive gases.

When hydrogen is evolved from a combustible substance, as gas, it is gaseous alkalinity presented to the atmospheric air, which consists of nitrogen and oxygen, or the principle of acidity in a gaseous state. The alkaline and acidulous atoms combine into a neutral fluid, but all the motion in their gaseous forms is thereby parted with, and this motion is the local heat of all fire.

As we have, in general, no power over the atoms of bodies but by putting them into motion, and thereby destroying their cohesive entanglements and inter-twistings with one another, so *heat is the primary agent in all the arts of life, and its nature should be thoroughly understood.*

A mere blow with a hammer reduces some bodies to powder, and the momentum is thereby exhausted. But in other cases no breaking or sensible dispersion takes place, and the momentum then produces an explosive tendency which we can feel as heat and as vibration, and can smell and feel in the radiations, and can see in vapour, if we put water or any moist substance on the excited mass. The economy and variation of this principle in condensations, fixations, &c. is our fire; and, in truth, our power over nature and the atomic world.

Some bodies are more excitable than others—some break—some evaporate—some silently expand, and in various degrees—some radiate—some absorb—some disperse—some combine with other bodies, and form new compounds—and it is the knowledge of these variations, and the dexterous application of them to effect desirable results, that constitute the skill of the chemist.

But we can expect to arrive at just and useful conclusions only by returning to nature, and to her universal power in the government of inert and passive matter *in the laws of motion*, by which bodies acquire and exert relative powers on other bodies, in never-ending circles of change and phenomena.

In the burning of inflammable bodies, hydrogen, or the alkaline principle, is latent or dormant in the tallow, coals, wood, &c. but being excited and separated by the application of a burning body (said to light it,) the oxygen, or acidulous principle, in the air leaves its nitrogen, and combines, forming a neutral fluid, water, in a state of less expansion than gas. The previous motion, then, of the atoms of oxygen is transferred partly to the latent hydrogen, but chiefly to the substance with which the hydrogen was combined, and hence the flame, smoke, carbonic acid gas, and water, generated.

The flame or light is the excitement of every thing present, as the hydrogen, nitrogen, and the substance decomposed, all of which radiate heat to a certain distance, and affect the atoms of air by protrusions in right lines to great distances, in the important phenomena called light. And light is, in effect, a vibration in its radiating lines, since the excitement is not permanent, and in shifting, at every moment, over the surface of the flame, its excited atoms are reacted upon by the permanent gas of space; and hence the distances of the vibrations or waves of rays measured by Young, Frauenhofer, &c.

In the mean time, the smoke is a product of evaporation or imperfect combustion.

And carbonic acid gas is a product of the entanglement of the spare oxygen, with all the atoms engaged in the process.

Steam of water is the other product. And every part is effected according to the laws of definite proportions.

Bodies which, when made red-hot by continued access of heat, do not flame, have no hydrogen in them, and no means of fixing oxygen, so as thereby of themselves to continue the heat. The variation in the phenomena between a silicious mass and a coaly mass, is, that one becomes red-hot, and is kept so by continued heat, producing no chemical changes; but the other, when hot, evolves hydrogen, or the alkaline principle, in the state of gas, which, combining with oxygen, or the acid principle, in the state of gas, produces compounds, and feeds its own heat, or first flame, as long as the alkaline principle is evolved, and the fixation of the acid principle continues.

But, in electricity, we appear to collect the pure acid and pure alkaline principles, and by concentrating them *in points*, we get the intense heat of their condensation, and also light by their combustion or dispersion of whatever they find at the place of union.

Heat is the motion, momentum, and excitement, of atoms. Combustion is the union of the acid and alkaline gases in the atmosphere and the substance.

Heat increases solvent power, owing to the increased motion, or action, of the atoms of the solvent, on the patient atoms of the other, or owing to the simultaneous effect on the atoms of both.

Heat remains longer in a vessel polished on the outside than in one rough, because the latter augments the radiating points.

Heat swells and expands bodies, by creating or enlarging the orbits of the gaseous parts in the interstices, while the action of these destroys the crystalline and cohesive structure, and converts the solid into a fluid, and this into gas.

*Specific heat*, is the measure of the degree of the *facility* with which one body receives heat from another. Thus 100° of heat will in the same time render one body 90°, and another only 40°, which arises solely from the susceptibility of their atoms to motion. Then one is said, by a very awkward phraseology, to have 90 specific heat, and the other but 40°.

The formation of denser compounds by the union of the gases distributes their atomic motion, or heat, to other adjacent bodies, and this is conflagration.

Mercury expands 1-50th from 32 to 212, water 1-21st, fixed oils 1-12th.

One 4th by weight of salt added to water, reduces its freezing point to 4°. One 8th of nitre reduces it 26°. And one-half Rochelle salt to 21°.

The heat-conducting power of gold being 1000, those of silver are 973, copper 898, platinum 381, iron 374, zinc 363. tin 304, lead 180, marble 236, porcelain 122, and clay 114.

The foreign heat required by different bodies to display the same degree of heat or atomic motion, in equal volumes, has been determined to be as under, in the nearest round numbers:—

| | | |
|---|---|---|
| Hydrogen | | 21·4 |
| Oxygen | | 4·75 |
| Air | | 1·8 |
| Steam | | 1·55 |
| Carbonic acid | | 1·65 |
| Nitrogen | | 0·8 |
| Alcohol | (15·44) | 1·086 |
| Ditto | (9·44) | 0·93 |
| Blood (arterial) | | 1·03 |
| Water | | 1· |
| Milk | | 1· |
| Sulphuric acid (10 of water) | | 0·925 |
| Ditto (5 of water) | | 0·876 |
| Ditto (2 of water) | | 0·75 |
| Ditto ½ of water | | 0·5 |
| Ditto concentrated | | 0·339 |
| Blood venous | | 0·8928 |
| Nitric acid (39) | | 0·844 |
| Olive-oil | | 0·71 |
| Linseed-oil | | 0·528 |
| Spermaceti-oil | | 0·5 |
| Oil of turpentine | | 0·472 |
| Mercury | | 0·033 |
| Ice | | 0·9 and 0·8 |
| Scotch fir | | 0·65 |
| Pear-tree | | 0·5 |
| Oak | | 0·45 |
| Birch charcoal | | 0·395 |
| Pet coal | | 0·278 |
| Crown-glass | | 0·2 |
| Sulphur | | 0·19 |
| Iron | | 0·145 |
| Steel | | 0·123 |
| Copper | | 0·112 |
| Zinc | | 0·102 |
| Hammered copper | | 0·097 |
| Silver | | 0·082 |
| Tin | | 0·06 |
| Gold | | 0·05 |
| Lead | | 0·04 |

Thus the natural heat of water to ice is as 10 to 9, and by experiment we find that the heat which melts ice raises water 146°; the natural zero, therefore, of water is 1460 — 32 = 1428°; and so for others.

Again, gold at ·05, and pear-tree wood at ·5, indicate that 1-10th heat will raise gold to the heat of pear-tree wood.

In fact, the facility of acquiring heat is inversely as the numbers in the scale, *i. e.* $\frac{1}{\cdot 05}$ for gold, or 20 and $\frac{1}{\cdot 5}$ or 2 for pear-tree wood, or $\frac{1}{\cdot 2} = 5$ for crown.

glass, and to raise them to the same degree of heat 1-10th will do it for gold, that is required for pear-tree wood, and $\frac{1}{4}$th will do it for gold that is required for crown-glass, and $2\frac{1}{2}$ will do for pear-tree wood that is required for crown-glass.

*Liquids freeze as under :—*

| | Deg. |
|---|---|
| Oil of aniseed - - | at 64 |
| Olive-oil - - | 36 |
| Water - - - | 32 |
| Milk - - | 30 |
| Vinegar - - | 28 |
| Human blood - - | 25 |
| Wines - - - | 20 |
| Strong sulphuric acid - | 1 |
| Strong brine - - | 6 |
| Brandy - - | 7 |
| Alcohol - - | 11 |
| Mercury - - | 39 |
| Ether - - | 46 |
| Strong nitric acid - | 55 |

*Boiling points :—*

| | |
|---|---|
| Ether - - | 98 |
| Alcohol - - | 176 |
| Water - - - | 212 |
| Oil of turpentine - | 560 |
| Linseed-oil - - | 600 |
| Mercury - - | 650 |

*Melting points :—*

| | |
|---|---|
| Lard - - - | 97 |
| Myrtle wax - - | 109 |
| Tallow - - | 127 |
| Bleached wax - - | 155 |
| Sulphur - - | 234 |
| Tin - - - | 442 |
| Lead - - - | 612 |
| Zinc - - - | 700 |
| Brass - - - | 3809 |
| Copper - - - | 4587 |
| Silver - - - | 4717 |
| Gold - - - | 5237 |
| Nickel - - - | 20577 |
| Iron - - - | 21637 |
| Platinum - - | 23177 |

*Volatilizations :—*

| | |
|---|---|
| Camphor sublimes - | 145 |
| Sulphur evaporates - | 170 |
| Phosphorus distils - | 219 |
| White arsenic sublimes - | 283 |
| Sulphur sublimes - | 608 |

*Temperatures in the practice of Chemistry :*

| *Fahr.* | |
|---|---|
| 221 | Boiling syrup saturated with sugar. |
| $218\frac{3}{4}$ | Water with 1-5th of common salt boils |
| $216\frac{1}{2}$ | ———— 4-10th of muriate of lime boils. |
| 212 | Boiling point of pure water. |
| $207\frac{1}{2}$ | Temp. of water (or olive-oil, or castor-oil) heated by a bath of pure water : 4 deg. $\frac{1}{2}$ being lost. |
| 178 | Water begin to simmer. Alcohol, 22° Beaumé, boils in a water bath. |
| $173\frac{3}{4}$ | Alcohol, 30° Beaumé, boils in a bath. |
| $172\frac{5}{8}$ | Alcohol, 36 ditto. |
| $271\frac{1}{2}$ | ———— 40 ditto. |
| 167 | Very pure ether distils in a bath. |
| 122 | For drying vegetables. |
| $110\frac{3}{4}$ | Tea, coffee, or other hot liquors are usually drank. |
| $100\frac{1}{2}$ | A bath that the feet will bear. |
| 100 to 90 | For digestions. |
| 77 | For drying fruits, herbs, and the like. For fermentation. |
| $65\frac{3}{4}$ | Lowest ditto. |
| 32 | Melting ice. |

Bodies become red-hot at about 800°.

HECTARE, the usual multiple of the French *are*, in speaking of rents and produce of land. It is 100 ares, each of which is 1076·44 square feet English. Hence the hectare is 107644 square feet, and our acre being 43560 square feet, the *hectare* is 2·47 English acres. And 40·47 French ares are an acre, or each is 3·95 poles or perches.

HEDERÆ (GUM) exudes from incisions made in the hedera arborea, or tree ivy. This gum resin, when genuine, is of a bright transparent reddish brown colour, deeper than the hyacinth, and approaching to the garnet; when reduced to powder, of a saffron yellow, and of an agreeable aromatic taste and smell.

HEDGE HYSSOP, (*Gratiola*) in doses in powder of 15 grs. to half a dr. 2 or 3 times a day, is found to cure obstructions and scrophulous affections, and even lues venerea.

HEDGES, in England, are mostly constructed of white or black thorn, or quick, but the United States have the cockspur thorn, and the Virginia thorn, both excellent.

Strong stems should be notched, or pieces cut out half through. Below these young shoots spring and fill up the hedge.

According to Sir John Sinclair, Mr. Forbes, of Callander, planted six millions of thorns in 400 miles of road.

Hedges may be advantageously planted with prickly gooseberries, intermingled with black-currant bushes. This would add to the produce and luxury of the country, and, if general, would lead to no inconvenience. Gooseberry cuttings would also be cheaper than thorn, or any other plants. Apple, pear, plum, and cherry trees deserve also to be preferred to unproductive trees in every civilized country.

HELLEBORE, BLACK, in doses of 3 or 4 grs. of the root in decoction, taken 5 or 6 times a day, is highly useful in mania, dropsy, and worms; from 10 grs. to a scruple are a strong purge for plethoric habits of females. Our native hellebore is called the *fœtid*, and used to expel worms in children in a teaspoon of the syrup night and morning.

*Hellebore, white. Veratrum album.* A drastic emetic root, in doses of ½ gr. to 3 grs.; for horses ½ an oz. to an oz. in farcy; also used as a sternutatory, and in itch ointments; juice used to poison weapons in war or hunting. *American hellebore, Veratrum viride.* Root emetic. Also *V. sabadilla*, whose capsules and grains are caustic.

Two oz. of the root of white hellebore yield with water 9 drs. and 1 scr. of gummy extract; and the same quantity of root yielded with alcohol 7 drs. of resinous extract.

From 6 oz. of the roots of black hellebore, 6 drs. and 1 scr. were extracted by alcohol; and from the same quantity of root, 6 drs. and 2 grs. were extracted by water.

HELM, the combination of timbers forming a ships' rudder, worked by the tiller, rope, and wheel. The greater the ship's velocity, the greater the power of the rudder on the head and keel, since the reaction of the rudder is at the same time increased.

HEMLOCK, *(Conium)* is a biennial well-known native plant, with umbelliferous small white flowers, and brownish berries. The stem is thick and spotted, and the lower leaves smell unpleasantly and have a dark shining colour. The poisonous qualities are chiefly in the leaves, which must be kept from light and air, and when powdered be close stopped. The narcotic principle was analyzed by Dr. A. T. Thompson, and is called *concin*. Half a grain produces head-ache and vertigo; but hemlock powder is found serviceable in cancer, syphilis, and scrofula. A gradually increased dose of the juice is 12 minims to 50 or 60, and of the powdered leaves 3 or 4 grains.

Professor Geiger, of Heidelberg, has ascertained the base of the active principle of hemlock to be an organic salt, which opens an entirely novel series of these interesting organic substances; for it is volatile, and similar to a volatile oil. The base of the active principle is likewise an organic salt, but it is tenacious, admits of being reduced to a crystal, forms a crystalline salt, with acids, like hemlock, and has a disagreeable smell, though it is not volatile, unless it be decomposed.

Hemlock is a plant whose resinous extract is a deadly poison, by its effect on the nervous system, half a grain producing head-ache and vertigo, but the powdered leaves are used in medicine in doses of 3 grs. in glandular and cancerous diseases. Aconite, another poison, has been used for the same purposes.

HEMP, is of the same genus as the hop and nettle. Its seeds are food for birds, and the source of much oil; its leaves mix with tobacco; and its prepared fibres make cordage, &c. It flourishes in Russia and Canada. To obtain the fibres, the stalk is rotted in stagnant water for 10 or 12 days, or on grass in wet weather; but it vitiates water, kills the fish, &c. It is then beat, combed, &c. but these are noisome and unhealthy employments.

HENBANE is used as an anodyne in spasms, painter's colic, &c.; and the fomentations of its leaves are good in scrophula and cancer.

HEPAR, is the combination of sulphur with an alkali denominated liver of sulphur, from its brown-red colour. Chemists have applied the term *hepar* in a general way to all combinations of alkali, or earth, with sulphur or with phosphorus.

HERB BENNET, or Avens Root, is used for diarrhœa and colic, and is always a substitute for bark. The dose, in powder, is half to a dr. every 6 hours. It gives an agreeable flavour to beer.

HERBS, for pharmacy, should be collected when they are beginning to flower, and be gathered in dry weather in the forenoon. They should be dried quickly, by a gentle heat, and afterwards be kept dry and be excluded from light.

Discoloured and rotton leaves should be picked off, and the perfect part screened. When herbs are the subject, the quicker they are dried the better, and during the drying they should be spread thin, and turned. When dry, they should be shaken, to expel eggs of insects. Most plants, on becoming brittle, become more odourous.

HERMETICAL SEALING. Heat the end of the tube, or phial, with a blowpipe, common fire, or spirit lamp, and when at a red heat pinch it close with tongs; then heat it again, and firmly unite the parts.

HERNIA, is the escape, or rupture, of part of the viscera, and peritonium or sack, in the groin, navel, or interior part of the thigh. It is occasioned by undue straining, or sudden effort, and best relieved by a truss after being pressed back or reduced; but if not reduced, the truss must be worn with care, and exertions avoided.

HESPERIDEÆ, a genus, whose fruits are generally acidulous and refreshing, as the citron, lemon, Seville orange, orange, bergamot, shaddock, and lime.

HICCOUGH.—The following mixture never fails in the cure of this troublesome affection:—

Take of rectified sulphuric ether, 3 drs.; solution of subcarbonate of potash, 3 drs.; tincture of columbo, 3 drs;

camphorated mixture, 6 oz.—Three table-spoonsful to be taken every two or three hours.

HIGH-WATER, a phenomenon of the tides; the common rules for finding which are:—

1. To know the time of high-water at any full, or change by observation; and to be accurate, it must be the mean of many observations made at different times of the year.

2. To know the moon's age on the proposed day.

3. To know the time, after noon, when the moon arrives at the south.

The Moon's age is found, by adding the *Epact* for the year (the moon's age on the 1st of January) to the *epact* for the month, (the age of the moon on the 1st of the month if it had been new moon on the 1st of January,) and the day of the month. If the sum be less than a lunar month, it is the moon's age; but if greater, take a lunar month from it, and the remainder is the moon's age.

The epacts for the months are these: January 0, Feb. 2, March 1, April 2, May 3, June 4, July 5, Aug. 6, Sept. 7, Oct. 8, Nov. 9, Dec. 10.

Thus, to find the moon's age for June 10, 1828.

| | |
|---|---|
| Epact of the year ..... | 14 |
| Epact of the month .... | 4 |
| Day of the month ...... | 10 |
| | 28 days. |

The moon, when new, is south at the same time with the sun, and 48 minutes, or 8-10ths of an hour nearly later for every day of her age. Therefore, multiply the moon's age by 8, take away the units figure, and multiply it by 6, for minutes; the other figures are hours after noon. If they exceed twelve, the excess is the hour of southing on the following morning.

Thus, if the moon's age is 28 days, $28 \times 8 = 224$, or 22 hours, 24 minutes; that is, 24 minutes after 10 the following morning.

The high-water is found, by adding the time of the moon's southing to the time of spring-tide in the table. As, to find the high-water at Bristol for the 10th June, 1828.

Supposing the tabular number for

| | |
|---|---|
| Bristol to be .......... | 6h. 36m. |
| Add moon's southing . | 10h. 24m. |
| | 17 hours |
| Subtract | 12 |
| Remains | 5 o'clock. |

These rules are not perfect, but they serve for general purposes.

HIPPOCRAS.—In six quarts of Lisbon, and also of caraway for three days, digest one dr. of each of mace, ginger, cloves, nutmegs, and galangale, cinnamon two oz., and four drs. of white cinnamon; strain, and add 40 oz. of white sugar.

HIPPOCRATES' FLANNEL SLEEVE is used by distillers, &c. for pouring turbid liquors from one vessel to another, and sometimes rendered less permeable by powdered alabaster. It is a yard of flannel suspended as an inverted cone, usually to a hoop, and liquors are poured through it.

HIVES, are artificial receptacles for the breeding of bees, made of plaited straw or rushes, wood, or even of glass. *See* Bees. But, in Livonia, cavities are made in the trees of a forest for the purpose of receiving and rearing swarms of bees. Some of the proprietors have hundreds, and even thousands of bee-trees, in large oaks, firs, pines, alders, &c. It is not necessary to choose the finest trunks, for stunted trees are equally serviceable, if they have sufficient size. A bee-tree is worth more than if sold for wood. The pure air of the higher regions agrees better with the bees than the air in hives, and when garden-bees swarm, they swarm to the woods, whilst the bees of the woods never swarm to the gardens.

HOG, the name of an animal of all climates, very prolific, a sow rearing as many as it has teats, or 12, but a litter is often 18 or 20, twice in a year. All the varieties are descended from the wild boar, a very ferocious creature. Their sense of smell is acute, and they are much affected by those atmospheric changes which precede or accompany wind.

HOLLY.—Root, bark, and berries, are acrid, and purgative. They are externally used as emollient and resolvent. The berries roasted are used for coffee, and the bark yields bird-lime.

HOMBERG'S PHOSPHORUS.—The combination of lime and muriatic acid, which remains after distilling the volatile alkali from sal ammoniac, has usually an over-proportion of lime. If it be urged by a violent heat it fuses; and when cold it has the property of emitting a phosphoric light, when struck with any hard body.

HONEY, is the product of flowers, chiefly of the base of the pistil, where it serves to entangle the pollen. It may, by alcohol, be separated into two parts, yellow and fluid, and white and solid. It is separated from the combs by heating and stirring them in water, and then squeezing the honey through a cloth. Candia and the Levant produce the best, in rocks and hollow trees. And it is sometimes made from ripe grapes, by evaporating Must to a syrup; or collected from trees, as left by other insects. The whole economy of bees bespeaks design, purpose, and intelligence in the insects, under habits adapted to their powers and form.

Honey differs much in colour, and in consistence; it contains much saccharine matter, and, probably, some mucilage, from which it derives its softness and viscosity. Honey very readily enters into the vinous fermentation, and yields a strong liquor, called *mead*. There are two species of honey; the one is yellow, transparent, and of the consistence of turpentine; the other white, and capable of assuming a solid form, and of concreting into regular spheres. These two species are often united; they may be separated by means of alcohol, which dissolves the liquid honey much more readily than the solid. Honey has never been accurately analyzed, but some late experiments go to prove it to be composed of sugar, mucilage, and an acid.

The honey made in mountainous countries is more highly-flavoured than that of low grounds. The honey made in the spring is more esteemed than that gathered in the summer; that of the summer more than that of the autumn. There is also a preference given to that of young swarms. Yellow honey is obtained, by pressure, from all sorts of honey-combs, old as well as new, and even from those whence the virgin-honey has been extracted. The combs are broken, and heated, with a little water, in basins or pots, being kept constantly stirred; they are then put into bags of thin linen cloth, and these into a press, to squeeze out the honey. The wax stays behind in the bag, excepting some particles, which pass through with the honey.--*See* BEES.

Honey is supposed to undergo no alteration in the body of the bee, as it retains the odour, and not unfrequently the qualities, of the plants it was gathered from, so that it is sometimes deleterious, where poisonous shrubs abound.

HOOPER'S PILLS.—In eight oz. of water dissolve eight oz. of copperas, then mix two oz. of myrrh, four drs. of oppoponax, six oz. of canella, and 40 oz. of Barbadoes aloes.

HOOPING COUGH, a disease of children, which increases for three or four weeks, and then abates, especially if aided by change of air, and occasional emetics.

HOPS, a necessary ingredient of malt liquor, contains a rich bitter, and an aroma, which modifies the bitter, while its astringent ingredient destroys the fermentation. Quassia, used as a substitute, contains only the bitter, and not the aroma, or the astringent, and therefore fails, except when attempts are made to supply the other qualities of hops by other drugs. Ives has separated the aroma and tannen, in a yellow powder, one-sixth the weight of the hops, in a substance called lupuline.

The strobiles, or female flowers, are dried in charcoal kilns, till five lbs. of the green flowers are reduced to one lb. and they are then laid in heaps and bags. Their bitter aromatic arises from a substance called *lupilin*, forming a sixth part, which may be obtained by merely sifting with a fine sieve. They yield also an aromatic oil. A pillow of them is said to promote sleep, and a fomentation is useful in tumours.

Hops contain several elements of activity, not in its substitutes. Its bitter principle is tonic, its aromatic is warm and stimulant, and its astringent quality precipitates the mucilage, and thus removes the cause of fermentation. These several properties render it superior to quassia, gentian, &c.—*Paris.*

*Iron Hop Poles.*—M. Denis has published a treatise on the cultivation of the hop; in which, he recommends the substitution of iron-wires, for poles. These wires, formed in pieces of about three feet in length, and joined together, so as to resemble a surveyor's chain, are suspended horizontally between two posts of oak, placed at the extremities of the lines of hops, and supported by wooden props at regular intervals. The hops are planted at the distance from each other of eight feet, and are each left with four shoots, which are conducted by little rods to the iron chain, along which are trained two in each direction. About a fifth part of the original cost of poles is saved by this contrivance.

*Tincture of Hops*, is five oz. of hops to a quart of alcohol.

HOREHOUND is pectoral, and used in coughs and colds, or the leaves may be powdered, or the expressed juice infused for tea.

HORN, a tough, flexible, semi-transparent substance. The hollow horns of the ox, goat, &c. the hoof, the horny claw and nail, and the scale of certain insects, as the shell of the tortoise, resemble each other in chemical characters; but they differ very widely from stag's-horn, ivory, &c. Horn is distinguished from bone, in being softened very completely by heat, either applied immediately, or through the medium of water, so as to be readily bent to any shape, and to adhere to other pieces of horn in the same state. It contains but a small portion of gelatine, and in this it differs from bone, which contains a great deal. Horn consists chiefly of condensed albumen, combined with a small and varying portion of gelatine, with a small part of phosphate of lime. The fixed alkalies readily dissolve horn into a yellow saponaceous liquor.

The tasteful combs in imitation of tortoiseshell, called *French shell*, are made by heating bullock's horns, and then subjecting them to pressure between iron-plates. When made thin enough, they are heated again, shaped, stamped, engraved, &c. Their colour is variegated by nitric and sulphuric acid, so as closely to resemble tortoiseshell, but they are afforded at a fifth of the price. Fashion leads to great consumption, and to much employment in making them, both in Paris and London.

HORNBLENDE, an abundant crystallized mineral, the constituents of which are silex, magnesia, lime, alumine, prot-oxide of iron, &c. It is green, white, brown, and black.

The lustre of hornblende is vitreous, inclining to pearly, upon the faces of cleavage, in the varieties possessing pale colours. Colour, various shades of green, often inclining to brown, white, and black, with every intermediate shade; nearly transparent in some varieties; in others opaque; brittle; hardness about the same with feldspar; specific gravity, 3·00. Three varieties, analysed by Bonsdorf, gave the following results:

| | *white* | *green* | *black* |
|---|---|---|---|
| Silex, | 60·31 | 46·26 | 45·69 |
| Magnesia, | 24·23 | 19·03 | 18·79 |
| Lime, | 13·66 | 13·96 | 13·85 |
| Alumine, | 0·26 | 11·48 | 12·18 |
| Protoxide of iron, | 0·15 | 3·43 | 7·32 |
| Do. of manganese, | 0·00 | 9·36 | 0·22 |
| Fluoric acid, | 0·94 | 1·60 | 1·50 |
| Water, &c. | 0·10 | 1·04 | 0·00 |

Of those varieties of the present species which have obtained distinct names, and which, in some systems of mineralogy, have ever been regarded as forming separate species, the following are the most remarkable, viz. *hornblende*, *tremolite*, *actynolite*, and certain kinds of asbestos. Hornblende differs from the rest principally by its dark, blackish, or greenish colours, and is divided into three sub-varieties, *basaltic hornblende*, *common hornblende*, and *hornblende slate*.

HORSE.—Known to most nations as the most useful and manageable of those animals that live under the sway of man. In gracefulness of form and dignity of carriage, he is superior to almost every other quadruped; he is lively and high-spirited, yet gentle and tractable; keen and ardent in his exertions, yet firm and persevering. The period of gestation is about 290 days. The young horse does not acquire his canine teeth till about his fifth year. The life of the horse, when not shortened by ill-usage, extends from 25 to 30 years. The most certain knowledge of the age of a horse, is to be obtained from the teeth. The 12 cutting-teeth begin to shoot about two weeks after the birth of a foal. These, as they are termed, *colt teeth*, are round, short, not very solid, and are cast at different periods to be replaced by others. At two and a half years, the four middle ones are shed; in another year, four others drop out; at four years and a half, the four last are cast; these latter are replaced by others called *corner teeth*. They are easily known, being the third above and below, counting from the middle of the jaw. They are hollow, and have a black mark in their cavity. When the horse is four and a half years old, they are scarcely visible above the gum, and the cavity is very sensible: at six and a half, they begin to fill, and the mark continually diminishes and contracts till seven or eight years, when the cavity is filled up and the black mark obliterated. After this, the age is to be judged by the canine teeth or *tushes*. The two in the lower jaw usually begin to appear at three years and a half, and those of the upper jaw at four, continuing very sharp-pointed till six. At ten, the upper seem blunted, worn out and long, the gum leaving them gradually; the barer they are the older is the horse; from 10 to 14, there is little to indicate the precise age. The age of a horse may also be ascertained, though less accurately, by the bars in his mouth, which wear away as he advances in years.

Desmarest gives upwards of 20 varieties of the horse, and his catalogue is by no means complete.

The most-esteemed horses are the Arabian. These are seldom more than 14 to 14½ hands high, more inclined to be lean than fat; they rise higher from the ground than other blood-horses, and gather much more quickly. The breed in Arabia is never crossed, as in other countries, but preserved unmixed with the utmost solicitude. The Arabs prefer the mare, as being more capable of bearing hunger, thirst, and fatigue; and these must neither bite nor kick, or they are deemed vicious; indeed, it is no uncommon thing to see children play and fondle about the mare and her foal without fear or injury. Madden says, when an Arab sells his mare, he rarely sells all his property in her; he generally reserves the second or third foal. The genealogy of a full-blooded Arabian horse must be proved at Mecca, for one race only is valued, which is that of Mohammed's favourite mare. That author also observes, that it is so difficult to get a thorough-bred Arab mare to send out of the country, that he doubts if any ever go to Europe; those usually sent as such being Dongola horses, which are very inferior, being worth only 20*l.* or 30*l.*, whilst an Arabian is worth from 300*l*. to 400*l*. The Arabians keep their horses picketed by the fore-legs. They never lie down, night or day, being always kept standing; even after a long journey, they are only suffered to give a tumble or two on the sand, and then made to rise.

A perfect horse should have the breast broad, the hips round, and the mane long, the countenance fierce like a lion, a nose like a sheep, the head, legs, and skin of a deer, the throat and neck of a wolf, and the ear and tail of a fox.—*Buffon.*

Stage-coach horses, on dry food, require two pecks, or four gallons of oats, and 15 lbs. of hay per day. Crushed beans, with oats, and their straw in chaff, and some oats, effect a better purpose than oats and hay, and at less expense. Others give each horse one gallon of oats, one of beans, and three of chaff of hay, straw, and clover, mixed together. Turnips and potatoes steamed together are also as good as grain when mixed with chaff. The same serves too for cattle. All grain should be crushed, or it passes whole, and it is preferred as a mash, to being dry. Chaff and dry-corn are exploded by good managers, and is a loss of one-eighth.

By cutting the hay and straw, and bruising, boiling, or steaming the oats, there is not only less waste, by the whole being used as manger-meat, but much labour is saved to the animal, in having the tough-dried hay and hard oats masticated for him, and in a state almost prepared for digestion; and, as regards the oats, all the nourishment they can afford is readily yielded to the digestive organs; for, unless the grain is broken down, or otherwise killed by boiling, it is not acted on in the stomach, and will even grow readily after having passed through the horse.

The custom of feeding horses with coarse bread is common in France, as more wholesome, more economical, and more portable than oats. The ingredients for making such bread are, five gallons of oat flour, ditto of rye flour, yeast, one gallon and a half of potatoes, reduced to pap. With bread made from these materials, 12 lbs. cut into pieces serve each horse, mixed up with straw, chaffed and moistened. No English horses perform more severe labour than the French on bread diet, while the form in travelling, &c. is very convenient.

HORSE-HAIR, is the hair of the tail twisted round wooden cylinders, and baked, to make cushions, chair-bottoms, &c.

HORSE-POWER; the force of a machine called a one-horse power is, in various circumstances, as under: for other horses, the effects are a multiple, by the number of horses.

By a pump, 250 hogsheads of water, 10 feet in an hour.

By wheel-work, 100 spindles of cotton yarn twist.

By ditto, 1000 spindles of mule yarn, No. 110.

By ditto, 12 power-looms, with preparation.—*Brunton.*

Watt estimated horse-power at 44,000 lbs. of water, one foot per minute, for a horse will draw 200 lbs. $2\frac{1}{2}$ miles, or 1300 feet per hour; *i. e.* 217 feet per minute, which is 43,400 lbs. one foot, or one lb. 43,400 feet.

Horse-power varies with speed, and at full-speed he carries only his own weight. If his force at six miles an hour is 36, at five miles it is 49, at four miles 64, at three miles 81, and at two miles 100. His power is equal to that of five men, or such, that he can raise 33,000 lbs. one foot in a minute, or 1000 lbs. 33 feet in a minute. All animal power is greatest, when the velocity is half that which can take place without obstacle.

Mr. Stuart, of Closeburn, employs horse-power to draw heavy loads, by dividing the road *into short stages.* Before this expedient, each horse could travel the distance of only 18 miles, and return with a load of 24 cwt. thrice a week; but, by dividing that distance into four stages of $4\frac{1}{2}$ miles each, four horses can make three trips daily, and draw a load of 33 cwt. each trip. Hence, according to this method, the aggregate of the labour of each horse amounts to above seven tons weekly. Were this distance divided into six stages, the load might be proportionally increased, with less fatigue to the horses; for it is invariably found, that the most profitable mode of applying the labour of horses is to vary their muscular action, and revive its tone by frequent intervals of repose.

HORSE-RADISH, *(cochlearia)*, is a perennial hardy plant, whose roots, when fresh, or preserved in sand, is stimulating, diuretic, and rubefacient. Its acrid taste depends on an essential oil of great pungency, which may be obtained by mashing it, and distilling it in water. The syrup is good for hoarseness, by a decoction of one part with eight parts water and sugar.

HORTICULTURE, the most important and satisfactory pursuit of man, has within a few years been carried to wonderful perfection. The Horticultural Society of London has been imitated in every part of the United Kingdom, in all the nations of Europe, and in the United States. The result has been the perfection of fruits, and a vast increase of luxurious garden-produce; besides pleasing improvements in flowers, and ornamental plants. We learn, from the Encyclopædia Americana, that North America has 140 forest-trees, among which are 53 species of the oak, 17 of the pine, 15 of the walnut, and 8 of the maple, while Europe still has but 37.

Horticulture has converted the almond into the peach, the sloe into the plum and green-gage, the crab into the highly-flavoured, and often gigantic apple, and the colewort into the cabbage, brocoli, and cauliflower. In like manner Bakewell changed the breeds, forms, and characters of animals, by due management, and such is the silent progression of natural operation in all other things.

An alternation of garden crops has been recommended.—1. Brocoli, cabbage, cauliflower, and savoys.

2. Common beans, French beans, and peas.

3. Carrots, beets, and parsnips.

4. Turnips, early potatoes, onions, leeks, eschalots, &c.

5. Celery, endive, lettuce, &c. &c.

Celery constitutes an excellent preparation for asparagus, onions, and cauliflowers. Turnips or potatoes are a good preparation for cabbages, or greens. Brocoli or cabbages are a proper preparation for beans or peas. Cauliflowers prepare well for onions, leeks, or turnips. Old asparagus land affords good preparation for potatoes or carrots. The strawberry, currant, gooseberry, and raspberry, for the same. Turnips give a suitable preparation for celery or endive; and peas, when well manured, are a good preparation for spinach, &c.—*M'Intosh.*

In *January*, little can be done in gardens. The walks should be swept and the beds kept clean, so that all may have as neat an appearance as possible.

*February.* Any rough work may be done in this month, but turf and gravel should not be laid till April. The turf of a town garden requires to be renewed every year. If frames or hand-glasses be admitted, dahlias and other fleshy-rooted-plants may be potted, and sheltered from the cold till March or April.

*March.* In the beginning of this month see that the ground be properly trenched and prepared for planting. A good stock of annual seeds should be procured, and, about the 20th, sown in patches on ground which has been carefully dug and raked. If there be hand-glasses, &c. the tenderer sorts may be introduced. Mignionette, Virginia stock, Lobel's catchfly, poppy, larkspur, purple œnothera, snapdragon, lupines, and sweet-peas, are good sorts for a town garden, among the hardy annuals; marvel of Peru, love-lies-bleeding, prince's feather, and red zinnia among the more tender.

*April.* Where any trees or shrubs are wanted, this is the season of planting in London. Perennial flower-roots may now be planted, such as St. John's wort, fraxinella, perennial sunflower, and dahlias, in the open ground. Attend to weeding and watering the seeds sown last month. Turf should now be laid, and gravel-walks made, picked, or rolled, as they require.

*May.* Keep all things perfectly clean. Attend to your annuals, which will now require thinning and regular watering, and more seed may be sown for late blooming. Plant geraniums and all other ornamental plants, of which great choice may be had at Covent Garden market. A water-engine should be used, and will be found truly beneficial in washing the soot off the plants.

*June.* The same directions apply to this month also. Watch and carefully pick off the plants all grubs and insects of every description, and destroy worms, snails, and slugs, by copious watering with lime-water.

In *July*, *August*, and *September*, the directions for May equally apply.

*October.* The frost and soot now attack, with deadly force, every plant unfortunate enough to find itself in town gardens. Cut off the leaves and stems as they become disfigured or perish. Take up the roots of dahlias, marvels of Peru, &c. and preserve them in dry sand.

*November.* Trench the beds two spits deep, and leave the earth in as rough a state as possible, to be pulverized and sweetened by the action of the frost. This is essentially requisite, for the smoke will otherwise render the earth sour and of a fœtid smell.

*December.* Nothing to be done, unless it be contemplating and laying plans for your spring-work. *Gard. Mag.*

Blossoms and fruit are protected from frost, in the great fruit-gardens west of London, by placing a broad board horizontally against the wall, near the top. It interrupts the descent of the cold air.

Apple-orchards produce good grass, provided they are not planted too close, which sours the grass and rusts the trees.

An acre of pear-trees converted into perry is equal, in value, to an acre of good vines.

Graft the golden-pippin on the Siberian crab.

*Gooseberry cuttings* should be planted in a lump of clay, mixed with cow-dung and some drops of oil, or in clay, with gypsum.

*Pears.*—Grafts upon quince stocks, instead of upon their own species, increases the produce, on the average, as 7 to 1 in favour of the quince; and in one case it has been found as 15 to 1. Pears grafted upon the quince have also the merit of not occupying so much space as others.

Gardening is still grossly neglected in districts remote from large towns, and market-gardeners unknown even in whole counties. Every landowner should stipulate for at least 1 acre in 50 for garden produce; and, if 2 acres, they would yield as much food as the 48. A single rood, or 1210 square yards to every cottage, furnishes a third of its consumption, and twice the quantity would enable them to supply town markets.

HORTUS SICCUS, is a collection of dried plants, pressed in a box of sand with screws and blotting-paper, and then laid smooth between writing-paper, inscribed with name, genera, species, and habits.

HOT-HOUSES.—Mr. A. M. Perkins has patented a plan for heating hot-houses by the circulation of hot water in hermetically-sealed tubes of small diameter. For experiment, he put up an apparatus, consisting of a series of pipes, of only an inch in diameter, so connected together as to form a complete circuit round the house; 1-4th part of these pipes, in the form of a coil, was placed in the flue of a fire-brick furnace, of a peculiar construction, and the other 3-4ths were exposed to radiation within the house. The result was a gradual rise in the thermometer, in the house, from 45° to 90° in four hours, without once stoking the fire from the time of lighting. The fuel is coke. Experiments have proved its capability of sustaining an equality of temperature for 10 hours, without the attendance of a stoker.

HOUSE LEEK, is cooling, astringent, and diuretic. The *Common great house leek* is cooling and astringent. It is also used externally to corns.

HUNGARY WATER.—Distil 2 lbs. of fresh rosemary flowers in 3 lbs. of alcohol.

HUXHAM'S Compound Tincture of Bark. Alcohol 20 oz., to which add 2 scrs. of cochineal, 1 dr. of crocus (or saffron,) 3 drs. of Virginian snake-root, 1½ oz. of orange-peel, and 2 oz. of Peruvian bark.

HYDRATE, a term employed to express a chemical combination of water, not in the state of moisture, with some other substance.

HYDRAULICS.—The pressure of water is always as the depth or weight, and as the surface, however immersed, from the surface of the fluid to the centre of gravity of the body.

The bottom of an upright vessel is pressed by the whole weight of the water contained in it, and every cubic foot is 1000 oz.

The sides sustain a pressure equal to the area of the sides by half the depth; therefore, the sides and bottom conjointly sustain a weight equal to three times the water.

So the bottom of a cone, or pyramid, bears the pressure of a body of water equal to the base and the whole height; *i. e.* three times the weight of the water in the vessel.

The velocity of the flow of water from any orifice is the square root of the depth by 5·4. The quantity in cubic feet, in a second, is that product by the area of the orifice in feet.

The force on an overshot water-wheel is that of the weight of the water falling on it, the power being to the effect as three to two. The force on an undershot-wheel is the velocity of the body of water, the power being to the effect as three to one, or half the other.

The particles of fluids are found to flow over or amongst each other with less friction than over solid substances; and as each particle has weight, it follows that no quantity of homogeneous fluid can be in a state of rest, unless every part of its surface is on a level. As the particles of all liquids are heavy, any vessel containing a liquid will be carried towards the earth by the two-fold motion, with a power equivalent to the weight it contains, and, if the quantity of the fluid be doubled, tripled, &c. the influence will be doubled, tripled, &c.

The pressure of fluids is, therefore, simply as their heights—a circumstance of great importance in the construction of pumps and engines for raising water. As atoms of liquids fall independently, if a hole be made in the bottom of the vessel the liquid will flow out, those particles directly over the hole being discharged first. Their motion causes a momentary vacuum, into which the particles tend to flow from *all directions*, and thus the whole mass of the water, and not merely the perpendicular column above the orifice, is set in motion.

When water flows in a current, as in rivers, it is in consequence of the inclination of the channel, and its motion is referrable to that of solids descending an inclined plane; but, from want of cohesion among its particles, the motions are more irregular than those of solids, and involve difficult questions. The friction between a solid and the surface on which it moves can be accurately ascertained; but this is not the case with liquids, one part of which may be moving rapidly and another slowly, while another is stationary.

In rivers and pipes, the water in the centre moves with greater rapidity than at the rubbing sides, so that a pipe does not discharge as much water in a given time, in proportion to its magnitude, as theoretical calculation would lead us to suppose. As water, in descending, follows the same laws as other falling bodies, its motion is accelerated; in rivers, therefore, the velocity and quantity discharged at different depths would be as the square roots of those depths, did not the friction against the bottom check the rapidity of the flow.

The same law applies to the spouting of water through jets or adjutages. Thus, if a hole be made in the side of a vessel of water, the water at this orifice, which before was only pressed by the simple weight of the perpendicular column above it, will be pressed by the same force as if the water were a solid body descending from the surface to the orifice; that is, as the square root of the distance of those two points; and, in the same way, water issuing from any other orifices, will run in quantities and velocities proportionate to the square root of their depths below the surface. Now, the quantity of water spouting from any hole in a given time must be as the velocity with which it flows; if, therefore, a hole, A, be four times as deep below the surface as a hole, B, it follows that A will discharge twice as much water in a given time as B, because two is the square-root of four. A hole in the centre of such a column of water will project the water to the greatest horizontal distance (or range,) which will be equal to twice the length of the column of which the orifice is the centre. In like manner, two jets of water, spouting from holes at equal distances above and below the central orifice, will be thrown equal horizontal distances. The path of the spouting liquid will always be a parabola, because it is impelled by two forces, the one horizontal, and the other perpendicular.

HYDROGEN, the lightest of the gases, being 16 times rarer than oxygen, 14·4 times rarer than air, and 14 rarer than nitrogen, has by many chemists been considered as the principle of alkalinity; and by others, as Murray, as the cause of that activity which arises when concrete acids and alkalies are dissolved in water, previous to which they exhibit no relative action. By combining with oxygen, it becomes the principle of inflammability, or of flame and combustion. If we could suppose that hydrogen were combined with nitrogen in the air, it would explain many phenomena. Flame is universally the union of oxygen and hydrogen, and it varies in colour and character as other bodies mingle either with the oxygen or the hydrogen. The principle is the evolution by heat of this rare gas, and its union and great condensation by another, oxygen.

Hydrogen and oxygen form water. Hydrogen and oxygen generate heat, and, lighted, a blue flame. Hydrogen, oxygen, and carbon, white light. Hydrogen and chlorine, by detonation in light, muriatic gas. Hydrogen and nitrogen, ammonia. Hydrogen and carbon, carburetted hydrogen. Hydrogen and sulphur, sulphuretted hydrogen. It also combines with iodine, prussiac, phosphorus, arsenic, and tellurium.

Hydrogen is made from water, by pouring 5 or 6 parts of water on 1 sulphuric acid, and putting some zinc, or harpsichord wire into it, in a glass vessel, into which a bent tube is fixed. Bubbles of the gas then rise in the tube, and may be conveyed to jars placed over water, or mercury. If the jar of gas be lifted up, and a lighted taper put into it, it will extinguish the taper, but itself take fire and burn with a blue flame in the part next the air. If it escape through an upright tube, it will burn like a candle.

In making hydrogen gas, by decomposing water, a troy oz. *i. e.* 480 grs. of zinc and dilute sulp. acid, give 676 cubic inches; and 1 of iron gives 782 cubic inches of hydrogen. The iron is combined with carbon, to be removed by passing the gas through alcohol. The impurities of zinc gas are removed by passing the gas through a solution of caustic potash. It has then neither taste nor smell, and its specific gravity is to air as 0·068 to 1.

The other product besides hydrogen, when zinc is used is oxyde of zinc, and when iron is used, is the sulphate of the protoxide of iron. Water is formed by chemically combining 8 weights of oxygen with 1 weight of hydrogen; or 1 volume of oxy. with 2 volumes of hydr.

Hydrogen combines with the simple solids, only when they are in a fluid state.

The subtle power of hydrogen and of hydrogen compounds may arise from the intense motions of the ultimate hydrogen atoms.

Hydrogen lowers tones, but sound is accelerated in it. When mixed instead of nitrogen with oxygen, in like proportions, animals breathe it, since respiration is only concerned with the oxygen, but it is stated that it causes sleep.

Hydrates are combinations of water with acids or their bases.

Muriatic acid, or hydrochloric acid, is a combination of chlorine and hydrogen, formed by solar light. They explode, and the result is muriatic acid gas at a mean of their sp. gr. and in equal bulk to each of them.

HYDROMETER, is an instrument to determine the specific gravities, or relative number of atoms, in equal bulks of bodies. It is made in a delicate bottle-form, with a long graduated stem.

The hydrometer of Fahrenheit consists of a hollow ball, with a counterpoise below, and a very slender stem above, terminating in a small dish. The middle, or half-length of the stem, is distinguished by a fine line across. In this instrument every division of the stem is rejected, and it is immersed in all experiments to the middle of the stem, by placing proper weights in the little dish above. Then, as the part immersed is constantly of the same magnitude, and the whole weight of the hydrometer is known; this last weight, added to the weights in the dish, will be equal to the weight of fluid displaced by the instrument, as all writers on hydrostatics prove. And, accordingly, the specific gravities for the common form of the tables will be had by the proportion:

As the whole weight of the hydrometer and its load, when adjusted in distilled water,
Is to the number 1,000, &c.
So is the whole weight, when adjusted in any other fluid,
To the number expressing its specific gravity.

Nothing more is required on the part of the workman, than that the hydrometer shall be light enough to float in ether, and capable of sustaining at least one-third of its own weight in the dish, without oversetting in a denser fluid. This last requisite is obtained by giving a due length to the stem beneath, to which the counterpoise is attached.

Beck's hydrometer begins 1, at 1° of the areometer, and ends at 0·7906 at 45°. Beaumé's begins 1 at 10° and ends 0·7252 at 62. For heavy fluids both begin at the same point, but Beaumé's 45° is 1·45, and Beck's 1·36, and at 60° they are 1·7012 and 1·5454. Beck's 76° corresponds with Beaumé's 65°.

HYDROPHANES, a stone, which is also called oculus mundi, and lapis mutabilis, was formerly of great value, and its distinguishing characteristic is that of becoming transparent by immersion in water.

It is either of a whitish brown, yellowish green, milky gray, or yellow colour, and opake. Without addition, it is infusible; but the flame of the blow-pipe changes it into a brown brittle substance. Neither acids nor alkalies have any action upon it in the humid way. When it has lain in water some hours it becomes transparent, and of a yellow amber colour. This change begins soon after the immersion, and at one end, in the form of a small spot (but in a small one of the same kind the beginning is round the edges), which increases by slow degrees, till the whole stone has become uniformly clear throughout. When taken out of the water, it loses its transparency, first at one end, and then gradually over the remainder.

The value of the hydrophanes is estimated by its bulk, the quickness of the change, and the beauty of its colour. Of two equally penetrable, the larger must be longer in becoming transparent; but the effect may be increased by giving them a flat thin figure. Hot water produces the effect more speedily than cold. Alkalies, or acids, penetrate this stone, and render it transparent; the concentrated sulphuric acid renders it permanently so, by attracting water from the atmosphere. But the opacity may be restored by immersing it in a hot alkaline liquor.

This stone received the name of oculus mundi, from an internal spark, or luminous spot, which changes its position according to the direction of the incident light. Bergman has made the most accurate remarks on this phenomenon, and finds that it proceeds from the caustic curves and focal image, by refraction from the usual rounded form of the stone, and rendered visible by the semiopacity of the material through which the light passes.

If the hydrophanes be made completely dry, and then steeped in melted wax, or spermaceti, it acquires the property of being rendered transparent by heat.

HYDROPHOBIA. After being bitten by a rabid animal, the safest remedy is a cautery of iron at a white heat, and the white heat is preferable to red, as causing less pain. Most other means and medicines have failed. The virus is in the saliva. Very hot or very cold climates do not experience this disease. The bite of rabid wolves is even more dangerous than that of dogs.

HYDROSTATICS.—The fundamental truth, on which the whole science of hydrostatics rests, is equality of pressure. All the particles of fluids are so connected together, that they press equally in every direction, and are continually pressed upon. Each particle presses equally on all the particles that surround it, and is equally pressed upon by them; it equally presses upon the solid bodies which it touches, and is equally pressed by those bodies. From this, and from their weight, it follows, that when a fluid is at rest, and left to itself, all its parts rise or fall so as to settle at the same level, no part standing above or sinking below the rest.

Hence, if we pour water on any other liquid into a tube bent like a U, it will stand at the same height in both limbs, whether they are of the same diameter or not, *and thus a portion of the liquid, however small, will resist the pressure of a portion however large, and balance* *it.* In a common tea-kettle, for instance, water poured into the body of the vessel will rise to the same level in the nose as in the vessel; and if poured into the nose, the same will also be true, and the small column of water in the nose balances the whole column in the body of the vessel, and will continue to do so, however large the one and however small the other may be.

This principle of equal pressure has been called the *hydrostatic paradox*, though there is nothing in reality more paradoxical in it than that 1 lb. at the long end of a lever should balance ten pounds at the short end; it is, indeed, but another means, like the contrivances called *mechanical powers*, of balancing different intensities of force by applying them to parts of an apparatus which move with different velocities.

The same effect is produced in what is called the *hydrostatic bellows*. The tube is made to communicate with an apparatus constructed like a common bellows, but without a valve. If the tube holds an ounce of water, and has an area equal only to one thousandth of that of the top board of the bellows, an ounce of water in the tube will balance weights of a thousand ounces resting on the bellows.

*The hydrostatic, or hydraulic press of Bramah*, is constructed on this principle; a prodigious force is thus obtained with great ease, and in a small compass, so that, with a machine the size of a common tea-pot, a bar of iron may be cut as easily as a slip of pasteboard. A small forcing-pump takes the place of the tube in the instrument above described, and a pump barrel and piston is substituted for the bellows; water is then driven from the small pump into the large barrel under the piston, and the piston is thus pressed against the object to be operated upon. If the small pump have one thousandth of the area of the large barrel, and the force of 500 pounds be applied to its piston by its lever handle, the great piston will rise with a force equal to one thousand times 500 pounds, or more than two hundred tons.

Russell has made another hydraulic press for many current purposes, which presses from 100 to 1000 tons, and has been applied to washing instead of wringing, to oil-making, sugar, cyder, &c.

Upon the tendency of all the parts of fluids to dispose themselves in a plain or level surface, depends the making of *levelling* instruments.

HYGROMETER, an instrument or contrivance, by which the degree of temperature is noted at which moisture begins to be deposited upon a cold body: as we see in a bottle of wine brought from a cellar, or a decanter of water fresh filled from a well.

This is called the *dew-point*, as it is the temperature of grass when the dew first begins to form in a clear evening. Tables have been prepared, and generally accompany the hygrometer, by the inspection of which, after having found the dew-point, the elastic force of the steam may be ascertained, the expansion which it produces in the air, and its weight in a cubic foot. When consulted as a weather-glass, two things are to be attended to—the difference between the dew-point and the temperature of the air, and which is denoted in the register by the term *degree of dryness*, and the variations of the dew-point. In general, the chance of rain or other precipitation of moisture from the air, may be regarded as in *inverse proportion* to the degree of dryness. But, in making this estimate, regard must be had to the time of day at which the observation is made, for in settled weather the dryness of the air increases with the diurnal heat, and diminishes with its decline; consequently, a less difference at morning or evening is equivalent to a greater in the middle of the day. An increasing difference between the temperature of the air and the temperature of the point of condensation, accompanied by a fall of the latter, is a sure prognostic of fine weather, while diminished heat and a rising dew-point infallibly portend a rainy season. A sudden change in the dew-point is generally accompanied by a change of wind. The hygrometer is more to be depended upon than any instrument that has yet been contrived.

A rise in the *dew-point*, accompanied by a fall of the barometer, is an infallible indication that the whole mass of the air is becoming embued with moisture, and, therefore, that copious precipitations may be looked for. If the fall of the barometer take place at the same time that the point of precipitation is depressed, we may conclude that the expansion which occasions the former has arisen at some distant point, and that wind, not rain, will be the consequence. But when the air attains the point of precipitation with a high barometer, we may infer, that it is a transitory and superficial effect, produced by local depression of temperature.

Hygrometers are often made of catgut, or of some salt, which, by imbibing moisture, increases its weight.

HYPERICUM PERFORATUM, *(St. John's wort.)* The tops and flowers of this plant give out a blood-red colour to water and alcohol, and a fine bright crimson to vinegar. With the stronger acids it affords a yellow colouring matter. Alum with a little potash is the proper mordant for it: and a bath of water sufficiently impregnated with the juice of this plant, in which there is a due quantity of the mordant, will give a bright yellow to linen, woollen, silk, or cotton. If a larger quantity of the mordant be used, the tint will approach toward green: and the addition of solution of tin will give a rose, cherry, or crimson hue, with a fine lustre. The shade produced, and durability of the colour, depend chiefly on the heat of the bath, the time the stuff is kept in it, and the mordant employed.

With linseed-oil, and a little oil of turpentine, it makes a fine red varnish.

HYSSOP.–The leaves emmenagogue, pectoral, and used as tea. Soaked in water or wine, and applied as a cataplasm, they are a discutient for black eyes, and other contusions.

ICE, frozen water; but, as soon as the temperature is raised, the solid state again gives way to the liquid. Expose a glass, filled with water, to a degree of cold producing ice; an extremely thin film of ice is observed first on the surface of the water, in contact with the cold air. Slender threads of ice are soon seen to shoot out from the sides of the vessel, generally forming with it obtuse or acute, seldom right angles; from these rays, new ones continually shoot out, till the whole surface is covered with a single coating. While this process is going on, a great number of air-bubbles arise, as in boiling, which pass out of the water when the congelation is slow; but when it is sudden, they are frozen in, and by their expansion cause rents in the ice. Although cold generally produces contraction, ice occupies a larger space than water. It is hence specifically lighter, and floats upon it. Stagnant water freezes sooner than flowing water: perfect rest, however, seems to be unfavorable to freezing, for we know by experience, that water perfectly still is not frozen when its temperature is reduced much below the freezing-point; but a little agitation is necessary to change it into ice. Sea-water, and in general all salt-water, freeze with greater difficulty. Salt is, moreover, separated in the process of freezing, and precipitated to the bottom, so that ice from sea-water sometimes affords potable water. Salts, however, produce a degree of cold beyond the freezing temperature, and, by means of them, we can cool water much below the freezing point, while it still remains fluid. Most salts have this property; especially nitre, muriate of ammonia, and common salt. A degree of cold sufficient for the freezing of water may be produced by them in summer, or even over a fire. Artificial ice is formed, also, by exposing pure water, in proper vessels, to such freezing mixtures. With vitriolic ether, and still better nitric ether, artificial ice may be produced in the middle of summer and on the warmest days. Ice is formed in the East Indies, in Calcutta, and other places, principally by evaporation.

The more severe the cold is, the greater the hardness and firmness of the ice; and the ice of the polar regions can hardly be broken with a hammer. Within the arctic circle, the congelation begins by the first of August, and a sheet of ice, perhaps an inch thick, is formed in a single night. In a short time, the whole extent of the polar seas is covered with a vault several feet thick. The whalers call a large expanse of saline ice a *field*; one of smaller dimensions, a *floe*; when a field is much broken up, it is called a *pack*. If the ship can sail freely through the floating pieces of ice, it is called *drift-ice*. A portion of ice rising above the common level is called a *hummock*, being produced by the crowding of one piece over another. The *ice-blink* is a whitish appearance in the horizon, occasioned by fields of ice, which reflect the light obliquely against the atmosphere.

Mairan observed, that water, in freezing, has a tendency to form angles of $60^{\circ}$, and to form stars with six rays. Romé de Lisle calculates, that the primitive form of ice is an equilateral eight-sided figure. Hassenfratz has observed, that water, when it freezes under favourable circumstances, always assumes a hexahedral prismatic form.

*Preparation of Ice.*—After numerous trials made with different salts, for the purpose of converting water contained in a tin vessel into ice, during their solution, preference is given to a mixture of 4 oz. nitrate of ammonia, 4 oz. sub-carbonate of soda, and 4 oz. of water. This mixture, in three hours, produces 10 oz. of ice.

*Ice Plants* contain acetate of potash. They are very mucilaginous, and useful in inflammatory and bilious fevers.—The species *copticum* is also burned for barilla, and is used in the preparation of Morocco leather. The species *Reaumuria vermiculata* exudes common salt mixed with saltpetre.

ICELAND MOSS JELLY, is made by boiling a quarter of a pound in a quart of water to 3 half-pints; straining and adding a quarter of a lb. of sugar.

ILLUMINATION (*Gas, for*) is made of the most brilliant light from *cocoa-*

*nut oil.* Six gallons supply 30 lights for 10 hours, affording double the quantity of gas that is supplied by an equal quantity of fish oil. It requires no purification by lime-water, and does not choke the pipes with tar so much as fish oil. It is liquidated in a small copper and conveyed into the red-hot retort in a fine thread of drops. It consumes about 150 lbs. of coals for the above quantity, and the present cost is about 15*s*. for the cocoa-nut oil, and the coals 1*s*. 6*d*. The superentendant 3*s*. The apparatus is compact, and very simple. The gas pure and luminous.

Inflammable gases are those which rekindle paper which has ceased to flame, as oxygen, (1 oxygen with 2 nitrogen,) prot-oxide of nitrogen, 3 O. and 2 N.) nitrous acid, and the deuct-oxide of chlorine (2 ox. + 1 ch.) and the prot-oxide of ch. (1 ox.—4 ch.) Hence oxygen is evidently the supporter.

IMITATION PAINTING, is carried to high perfection, and the grain of every kind of wood is imitated. The lightest colour of the natural wood is the ground colour, thus in oak it is rotten stone and white. The graining or marbling is effected by a composition called *megilp*, and worked by combs with various arrangements of teeth corresponding to the various grains of woods. Dark touches are then pencilled in, and the whole glazed for cooling or warming and drying. The details are most ingenious, and for them the practical painter must refer to the elaborate instructions of Mr. N. Whittock, in his *Painter's Guide*.

INDIGO. From the differences which exist in the nature and culture of the *indigofera*, and of its treatment by the manufacturer, the product, *indigo*, as found in commerce, differs remarkably in quality and chemical composition. Besides the impurities accidentally present, from a bad season, want of skill or care, the purest commercial indigo consists of no less than five constituents—1. *Indigo-blue*, a very singular vegetable compound of carbon, hydrogen, and oxygen, with about ten per cent. of azote; 2. *Indigo-gluten*, a yellow, or brownish-yellow varnish, which differs from wheat-gluten by its solubility in water. It has the taste of osmazome, or of beef-soup, melts when heated, burns with flame, and affords an empyreumatic oil along with ammonia by distillation; 3. *Indigo-brown*, This constituent is more abundant than the preceding. It is extracted by a concentrated water of potash, made to act on powdered indigo, previously digested in dilute sulphuric acid. Chevreuil's indigo-green seems to have consisted of this substance, mixed with some alkaline matter, and indigo-blue. 4. *Indigo-red*, This is readily dissolved by boiling alcohol out of indigo previously subjected to the action of an acid or alkaline menstruum. The alcohol acquires a beautiful red tinge, and leaves by its evaporation the red principle in the form of a blackish-brown varnish; 5. *Phosphate of lime.* Dr. Ure found the bone phosphate in notable quantity in some fine indigo, constituting another feature of resemblance between this vegetable and animal products. Hence, also, the charcoal of indigo is most difficult of incineration, and requires, for perfect combustion in some cases, the deflagratory powers of nitric acid.—*Quar. Jour.*

The species of *indigofera* are leguminous plants, herbaceous or shrubby. They are very numerous in the equatorial regions of the globe. The *I. tinctoria* is the species most abundantly cultivated. The plant requires a rich, light soil, and a warm exposure. It succeeds best on newly-cleared lands, on account of their moisture; it requires protection against high winds, and needs irrigation in times of drought. The ground, after being properly prepared for the reception of the seed by ploughing, is sown pretty thickly, the time of sowing being so chosen that rain may fall upon the plant as soon as it shows itself above the ground, by which it is not only greatly invigorated, but cleansed from innumerable insects.

As the plant approaches to maturity, the leaves undergo a sudden change in colour, from a light to a dark green. As soon as this change is observed, the branches are severed from the parent stem early in the morning, and spread out in the sun till the afternoon, by which time they become sufficiently dry to be beaten from the branches by a stick. The leaves, so separated, are housed in warehouses, closely packed and well trodden down by natives.

The plants, from which leaves have been severed, send forth a new crop, which is gathered, when mature, like the first. The cuttings, in a favorable season, are repeated three or four times, after which the ground is ploughed up for another sowing; but each successive growth of the branches produces an increased deterioration of the qualities of the leaves, so that one part of the leaves of the first cutting yields as much indigo as two parts of the third crop. The dried leaves are not immediately used, but are kept packed for one month, during which time they suffer a material change, which is indicated by their having passed to a light lead color. By additional keeping, the lead color gradually darkens, until it becomes black. The maximum quantity of indigo is to be obtained when the lead color is attended with a loss in the quantity of the indigo. The dried leaves, after having suffered the change of color, are transferred to the steeping-vat (an uncovered reservoir, 30 ft. square and 26 inc. deep, constructed of brick, and lined with stucco,) where they are mingled with water, in the proportion of about one volume of leaves to six of water, and allowed to remain 2 hours.

The great affinity of indigo for oxygen is very manifest, in the quick change of the color of the leaves which float on the surface, and are exposed to the action of the atmosphere, to a blackish blue, when contrasted with those below, which remain unchanged. On this account, the vat is frequently stirred, so that the floating leaves may be immersed. After two hours' infusion, the water, which, from the solution of imperfectly-oxygenized indigo, has acquired a fine green color, is allowed to run off from the leaves, through strainers, into the beating-vat, where it is agitated by the paddles of 10 or 12 natives for about two hours, during which time the fine green liquor gradually darkens to a blackish-blue. At this time, lime-water is thrown into the vat, and thoroughly agitated with the whole mass of fluid. The mass is then left to subside for the space of three hours, when the supernatant liquid, which is of a fine bright Madeira color, is withdrawn, by orifices in the vat at different heights. The indigo is then removed to the covered part of the manufactory, where it is put on a straining-cloth, and allowed to drain throughout the night. On the following morning, it is transferred to a copper boiler, where it is mingled with a quantity of water, and raised to ebullition. The contents of the copper are retaken to the strainers, and the drained indigo is then divided into small portions, and each portion well worked by the hands of the natives, in order to free it from air-bubbles. It is then carried to the pressing-boxes, which are usually square, and of sufficient depth to leave the cake about two inches and a quarter in thickness. By means of a powerful screw, the water is separated from the indigo; the cakes are gradually dried in the shade, and thus rendered fit for exportation.

When indigo, suspended in water, is brought into contact with certain deoxidizing agents, it is deprived of a part of its oxygen, becomes green, and is rendered soluble in water, and still more so in the alkalies. It recovers its former colour, however, on exposure to the air, by again absorbing oxygen of 1-7th or 1-8th of the whole weight of the resulting indigo. Its deoxidizement is effected either by allowing it to ferment along with bran, or other vegetable matter, or by decomposing in contact with it the protosulphate of iron, by the addition of lime.

Substances dyed by deoxidized indigo receive a green tint at first, which becomes blue by exposure to the air. This is the usual method of coloring cloths by means of indigo, which, when fully oxidized, affords a permanent dye, not removable by soap or by acids.

Indigo, purified by sublimation, is composed of 73·26 carbon, 13·81 nitrogen, 10·43 oxygen, and 2·5 hydrogen.

INFLAMMATION, is such an accumulation of blood in a particular organ or part as creates an undue and painful action. When external it may often be relieved by local applications, but, when internal, as in the chest and viscera, general bleeding is properly resorted to; but to be effectual, it must be continued till the patient, by fainting, proves that it has reached the entire system. The cessation of action is a likely or the most likely means of arresting the inflammation, and unless the bleeding is carried to this precise extent, it may as well be avoided.

INFUSION, a term when volatile principles are to be abstracted; and, it should be remembered, that the aroma is first obtained, then the colouring, astringent and mucilaginous, in succession. Water should boil unless the substance contains starch, and then 170° or 180° is preferred by brewers.—Some substances require to be sliced, others to be bruised, and some pulverized.

INK, as it is usually prepared, says Dr. Bostock, is disposed to undergo certain changes, which considerably impair its value; tendency to mould, the liability of the black matter to separate from the fluid, the ink then becoming what is termed ropy; and its loss of colour, the black first changing to brown, and, at length, almost entirely disappearing.

With respect to the chemical constitution of ink, Dr. Bostock remarks, that although, as usually prepared, it is a combination of the metallic salt or oxide, with four vegetable principles, yet he is inclined to believe that three of them, so far from being essential, are the principal cause of the difficulty which we meet with in the formation of a perfect and durable ink. I endeavoured, says he, to prove this point by a series of experiments, of which the following is a brief abstract. Having prepared a cold infusion of galls, I allowed a portion of it to remain exposed to the atmosphere, in a shallow capsule, until it was covered with a thick stratum of mould; the mould was removed by filtration, and the proper proportion of sulphate of iron being added to the clear fluid, a compound was formed of a deep-black colour, which showed no father tendency to mould, and which remained for a long time without experiencing any alteration.

Another portion of the same infusion of galls had solution of isinglass added to it until it no longer produced a precipitate ; by employing the sulphate of iron, a black compound was produced, which, although paler than that formed from the entire fluid, appeared to be a perfect and durable ink. Lastly, a portion of the infusion of galls was kept for some time at the boiling temperature, by means of which a part of its contents became insoluble ; this was removed by filtration, when, by the addition of the sulphate of iron, a very perfect and durable ink was produced. In the above three processes I conceive that a considerable part of the mucilage, the tan, and the extract, were respectively removed from the infusion, while the greater part of the gallic acid would be left in solution.

His practical conclusions are as follow :—In order to procure ink which may be little disposed either to mould or to deposit its contents, and which, at the same time, may possess a deep black colour, not liable to fade, the galls should be macerated for some hours in hot water, and the fluid be filtered ; it should then be exposed for about 14 days to a warm atmosphere, when any mould which may have been produced must be removed. A solution of sulphate of iron is to be employed, which has also been exposed for some time to the atmosphere, and which, consequently, contains a certain quantity of the red oxide of iron diffused through it. He recommends the infusion of galls to be made of considerable greater strength than is generally directed ; and ink, formed in this manner, will not necessarily require the addition of any mucilaginous substance to render it of a proper consistence.—One of the best substances for diluting ink, if it be, in the first instance, too thick for use, or afterwards become so by evaporation, is a strong decoction of coffee, which appears in no respect to promote the decomposition of the ink, while it improves its colour, and gives it additional lustre.

Ink for writing is made by adding boiled infusion of nut-galls to sulphate of iron dissolved in water. Nut-galls and other substances which contain an astringent or tannin principle, precipitate a black powder from sulphate of iron made by decomposing iron or martial pyrites. The black precipitate is then held in solution by gum water. Logwood, sulphate of copper (blue vitriol) and sugar, are improvements.

Ink, when made, ought to be kept as much as possible excluded from the air, in a glass vessel, or an earthenware one, well glazed.

*To make Black Ink.* Take 8 oz. of galls in powder, 4 logwood in chips, 4 sulphate of iron, 1 sulphate of copper, 3 gum-arabic powder, and 1 sugar-candy. Boil the 2 first in 1½ gallon water to half, strain through a fine cloth, then add the rest, and stir well. In 24 hours decant and cork tight.

Another directs the logwood to be boiled first to five quarts, then double the galls and the sulphate of iron calcined.

*Or*, Take of galls 1 lb., green copperas 3 oz. 64 grs., gum ditto, water 3 quarts. Boil the galls, when bruised, with 3 pints of water till a quart of decoction remains ; pour it off, and add the remainder of the water, and again boil till a quart remains. Mix both decoctions, and dissolve the other ingredients in it ; let them stand for 24 hours, and pour off the fluid ink from the precipitate.

*Or*, To convert the tannin of the galls into gallic acid, a decoction may be made as above. Let it stand in the air for 10 days, agitating it 2 or 3 times a day. To a quart add 3½ pints of water, and to this add green copperas and gum, of each 9 oz. The sediment which forms may, after 3 days, be separated.

*Or*, Take of galls 1 lb. logwood 1½ lb. green copperas 18 oz. gum ditto. Make a decoction as directed, and convert it into gallic acid. When the process is ended, make a decoction of log-wood, by boiling it in 5 quarts of water till it is reduced to 7 pints. Mix this decoction with the solution of gallic acid, and dissolve the green copperas and gum. Let them stand for 2 or 3 days, and pour the ink off the sediment.

*Ink Powder.*—Mix together in powder 2 lbs. of galls, 1 lb. of sulphate of iron (clean green copperas,) and 8 oz. of gum arabic. *Or*, Calcine the copperas, and mix of it 6 drs. with 2 drs. of gum arabic, ½ dr. indigo, and 3 oz. of galls and of white sugar. Use 2 oz. to a pint of water.

*Red ink.*—In a pint of white wine vinegar boil well ½ an oz. of ground brazil wood, and add ½ an oz. of roche alum. *Or*, In a pint of sour good ale infuse 2 oz. of ground brazil wood and of roche alum, 1 oz. of gum arabic, and 1 dr. of cochineal.

*Invisible ink* is made by a solution of blue vitriol and sal ammonia. It is invisible cold, but visible when heated. So cobalt in aqua regia diluted gives green, when hot, and oxide of cobalt in acetic acid with some nitre gives a rose colour when hot.

*Or*, Form a solution of green vitriol in water, and add a little alum, to prevent the yellow iron precipitate from sinking, which always rises in case the acid does not prevail; this solution forms a sympathetic ink, which appears extremely black when it is moistened with a saturated infusion of gall-nuts.

*Or, a sympathetic ink* may likewise be formed from common black ink. For this purpose, the colour must be destroyed by a mixture of nitric acid. Any thing written with it becomes visible on moistening it with a solution of some volatile alkali.

*Indelible ink* is made by mixing asphaltum, oil of turpentine, amber, varnish, and lamp-black.—*Sheldrake.*

*Or*, Indelible Ink is made by decomposing gum arabic with strong sulphuric acid, by which much carbon is procured.

*Indian Ink.*—Burn oil under shades, and mix the black with ass's-skin glue. *Or*, Mix up Russian lamp-black with glue.—*Or*, In 4 oz. of water mix 5 scrs. of seed lac, 1 scr. of borax and lamp-black to the proper consistence.

*Gold and Silver Ink* is made by grinding leaves with sugar in a muller, putting it in water, and decanting the water and sugar; then mixing the metallic powder, as wanted, in gum-water. It writes as other ink, and may be polished with a dog's tooth.

*To restore Pale Ink.*—Ink made with either a diminished or an increased quantity of green copperas does not keep its proper colour, changing to a brownish black. When an excess of copperas has been used, and the writing has been suffered to remain till the colour has been thus impaired, it may be in some measure restored by a dilute sulphuric acid. Half a drachm, added to 2 oz. of water, brushed over the paper, produces the effect. But, if used in too large a quantity, or a stronger acid is used, it injures or destroys the colour.

*To take Ink out of Linen.*—One or two drops of aqua-fortis are sufficient for taking out a large spot of ink from linen, without impairing it in the slightest manner. It is only necessary previously to moisten the spot with and to rinse it afterwards in *water.—Mec. Mag.*

*Printers' Ink* is a very singular composition, partaking much of the nature of an oil varnish, but differing from it in the quality of adhering firmly to moistened paper, and in being, to a considerable degree, soluble in soap-water. It is, when used by the printers, of the consistence of rather thin jelly, so that it may be smeared over the types readily and thinly, when applied by leather cushions; and it dries very speedily on the paper, without running through to the other side, or passing the limits of the letter. It is made of nut-oil, boiled, and afterwards mixed with lamp-black, of which about two ounces and a half are sufficient for 16 ounces of the prepared oil. Other additions are made by ink-makers, of which the most important is generally understood to be a little fine indigo in powder, to improve the beauty of the colour.

*Printers' Red Ink* is made by adding to the varnish about half its weight of vermillion. A little carmine also improves the colour. Most of the common water-colour cakes, diffused in water, will make sufficiently good-coloured inks for most purposes.

INTEREST is calculated by the following formula, taking $r$ as the interest of 1*l.* per annum, $p$ the principal, $t$ the time, $i$ the whole interest, $a$ the amount of principal and interest.

$$a = p + p\ t\ r$$

$$p = \frac{a}{1 + r\,t}$$

$$r = \frac{a - p}{p\,t}$$

$$t = \frac{a - p}{p\,r}$$

$$i = p\,t\,r$$

In compound-interest, the amount for any number of years or payments is the log. of the amount of 1*l.* for the year, or payment multiplied by the number of years, or payment for the power of 1*l.*, and this by the log. of the principal. If the principal is deducted from the amount, it leaves the compound-interest for the time.

The law properly fixes the maximum of interest at five per cent., to protect borrowers from the extortion of usurers and capitalists. Hence, the usury laws are the sheet-anchor of trade and credit.

It is usual to calculate interest at 5 per cent. or 1*l.* at 1*d.* per month. To take 4-5ths of this for 4 per cent., 3-5ths at 3 per cent., and 9-10ths at 4½ per cent. Thus, 100*l.* for a month is 100 pence, then at 4 per cent. it is 80 pence, at 3 per cent. 60 pence, and at 4½ per cent. 90 pence.

Different amounts and dates are averaged as to time, by multiplying the several sums by the times, and dividing by the whole sum. The quotient is the true average time.

IODINE, in its origin, is an alkaline product of many sea-weeds, of sponge, and of kelp. It may be formed by pouring sulphuric acid on a very strong infusion of them, when iodine or violet vapour arises; or, better by concentrating a solution of kelp, separating the crystals, and mixing with the liquid an excess of sulphuric acid. Boil this, and sulphur is precipitated, and muriatic acid driven off. Decant, and strain through wool. Put it into a small flask, and introduce as much black oxide of manganese as was used of sulphuric acid. Keep in a flask fitted with a tube, and the iodine sublimes in the tube. Dr. Ure skilfully improves on this process, by using the alkaline kelp residium of the soap manufacturers. It requires one of sulph. acid to neutralize eight of it, and to 5250 grains of his resulting liquor, he added 1000 of oxide of manganese, and, at 2320, got 80 to 100 of iodine.

It appears, from its origin, to be an *alkali*, and in its developement, sulphur, oxygen, or manganese are freely used. If we may, in the face of all scholastic authority, hazard an opinion, we should regard the iodine as two sulphur, six oxygen, and two nitrogen, with one phosphorus 15·71 = 123·71; and the latter in the acid becomes 16·71, by being treated with iodine and *water*; hence, the acid is 124·71. Of course, this is offered as a mean.

Its specific gravity is 3·0844, and it has a semi-metallic appearance. It melts at 225°, and its equivalent is, per Connell, 126, usually taken 124. Iodic acid, formed by five more oxygen, is 166; and with two oxy-muriatic acid it is 198 as chloroidic acid. By the table of atomic proportions, it may be readily compounded of the equivalents of sulphur and oxygen, with an allowance for that of the kelp alkali. Its union with such large proportions of oxygen renders it one of the supporters, and in that sense the schools of chemistry regard it as a simple substance.

As a medicine, it stimulates the absorbents, and is the most efficacious known remedy for bronchocele, scrophula, dropsy, &c. Its vapour is also employed in diseases of the trachea and lungs. It is taken as a tincture from 12 to 25 drops per day, and applied externally as an ointment. The power of burnt-sponge, &c. is now ascribed to the iodine in it.

*Tincture of Iodine.*—In one ounce of alcohol infuse 60 grs. of iodine. The dose is 10 drops to 20, in water, for thick necks, (bronchocele.)

IPECACUANHA, or Cephaelis, is the root of a plant which grows on the coasts of Brazil. Several species promote vomiting, and this quality arises from a substance called *Emetina*, and often used instead of the powder. It is a safe, certain, and quick emetic, and its operation should be continued by warm liquids. In smaller does, it is used as a sudorific.

Ipecacuanha has been reduced to its essence as emetina, or its alkaline base as emeta; and a single grain is a powerful and useful vomit. Ipecacuanha is found to consist of 16 emetina, two oils, six wax, 10 gum, 40 starch, and 20 woody fibres. In small doses, the powder is a valuable stomachic. The lozenges contain half a grain of powder.

*Ipecacuanha Wine* is made by digesting, for seven days, two oz. of the bruised root in a quart of sherry. Filter.

IRRITATION, is a remedy to divert and diminish, by revulsion, any diseased action, since, in general, two undue excitements cannot exist together in the constitution. Counter-irritation is, therefore, a very important branch of the art of curing diseases. Internal medicines are in general mere counter-irritants. Externally, they are *Rubefacients*, as a bottle of hot water, or bag of hot sand, a mustard or pepper poultice, friction of essential oils, cotton, or flannel, wet with ether, &c.; or, *Vesicants*, as blisters, with thin paper between them and the skin, or hot water or metal, or liquor ammonia, with hogs-lard, (producing serous affusion); *Pustular*, as sulphuric and nitrous acids, with oil of lard, tartarized antimony (1), with spermaceti ointment (6 or 8), on the skin previously excited, (most efficacious, and to be moderated by warm bread poultices); *Constant*, as issues or ulcers, kept open by a pea, setons, or threads of caoutchouc, or lead, blisters kept open by ceratum sabinæ; *Cauterizing*, as hot vapour, metal at a white heat, limited in area by wet paper or cloths; (or produced by parallel interventions), and by moxa.—*Williams, Ency. Pr. Med.*

IRIDIUM, a combination with platinum. It is the powder which falls when platinum is dissolved in aqua regia. Its sp. gr. is 19·25, equal to gold. It is only known as powder.

IRIS, FLORENTINE, has a root, which, dried and powdered, has the odour of violets, and is much used by perfumers.

IRRIGATING MACHINES, for raising water to higher levels than 33 feet, are often made on the principle of Hero's Fountain, by which two vessels at bottom are filled by a fall, and then act alternately on two above, and these on others in several steps of ascent. It is necessarily complicated, and liable to get out of order, but it deserves adoption for its ingenuity.

IRON, is procured native, or as sulphuretted pyrites in a *metallic* state; or *oxydized*, as magnetic, spicular, redstone, and hydrate or brown; or acidified in salts, as carbonate or ore for smelting, phosphate, arseniate, chromate, silicate, sulphate, or pitchy. The carbonate or clay ore, and the oxydized red hæmatite. These, roasted with coals to expel the sulphur and gaseous matters, are then smelted in a furnace with coke, to which lime is added as a flux, to assist the separation of the metal. This is that vast manufactory of iron which, in Wales, Staffordshire, &c. employs such vast works.

Iron becomes oxydized in air, but in water it soon forms a protocarbonate, then a protoxide, and, finally, an hydratid peroxide. Its sparks oxidate when struck with flint. Its perfect oxide consists of 48 oxygen, and 52 iron.

Red, brown, black, and yellow earths and ochres, are oxides of iron.

Carbonate of iron, from which our iron is smelted, always accompanies the coal formation, and is commonly called clay iron-stone.

After being dug from the earth it is roasted, to drive off the carbonic acid gas, and by this it loses a third or fourth of its weight. It is then distributed in layers, with coke and limestone, in a furnace, from 40 to 60 feet deep. The limestone is used merely as a flux to detach the clay, and the iron is melted by the coke, kept in intense heat by enormous blasting bellows, worked by steam power. Three tons of ore require one ton of limestone, and 1½ ton of coke, to make one ton of pig-iron in 24 hours. The furnace is kept full for months, and if it wants repairing, or the demand slackens, the furnace is what is called *blown out*, or allowed to cool. The heating again is a work of time, and great expense of fuel. The scoriæ are of immense bulk, and form mountains near old iron-works.

In South Wales, the minerals are obtained by excavating a tunnel, or driving a heading, as it is technically termed, into the side of a hill. This tunnel is available as a road along which to bring out the coal and iron-stone, and at the same time as a drain for the whole of the works. The manufacture is divided into two heads: first, the production of *pig-iron* from the ore by smelting; and, secondly, the conversion of pig-iron into a *malleable state*, and the rolling of it into bars.

The external form of a Welsh furnace is a square mass of masonry, with a base of from 30 to 50 feet; these dimensions gradually diminishing to about 25 feet at the height of 45 feet from the ground. A cylinder of brick-work is then carried on to the height of 10 or 15 feet more, making a total height of 55 to 60 feet. There is a large roof extending from the sides of the furnace, to shelter the workmen, and keep the cast-house dry.

There is also a covered communication between the top of the square masonry and the high ground, for the purpose of supplying the materials. The cylinder at the top, called the tunnel-head, is furnished with from one to four doors or openings—generally two—opposite each other, through which are introduced the materials for the supply of the furnace: it is made of fire-bricks, hooped together with iron, and is about eight feet in diameter. The masonry of the whole furnace is also strongly bound together with iron stays. There are arches in the centres of the four sides, forming recesses in the solid masonry. That in front is to enable the workmen to work the furnace, and run out the iron; those at the sides are for the introduction of the blast.

The hearth and boshes are generally made of large pieces of a coarse grit, or pudding-stone, carefully jointed with fire-clay, so as to resist as much as possible the action of the intense heat to which they are to be subjected. Some hearths have been constructed of fire-bricks.

Another, and more simple form of furnaces, is called a cupola. It is in the form of a large chimney, and from the boshes upwards is simply the length of a single brick in thickness. It is held together by an iron hoop at every joint. The bricks are laid in fire-clay instead of mortar, and are from 15 to 17 inches long at the boshes, and gradually diminished upwards to the tunnel-head.

The blast is made through three recesses. The holes through which the blast is admitted to the furnace are called *twyeres*. The general practice in Wales is to blow with three twyeres. Frequently but two are used, and occasionally only one. Their management requires considerable practice and skill.

It is produced by powerful steam-engines, with one or two exceptions of water power. The blast-engine is supplied with a large cylinder at the opposite end of the beam to the steam cylinder, and of double its diameter. The blowing piston, therefore, will produce a volume of air at each stroke of the engine equal to four times the contents of the steam cylinder, but at a pressure of only one-fourth of that on the steam piston by the joint action of the vacuum and the steam, friction deducted. Thus, suppose that an engine with a steam cylinder 54 in. diameter, and a pressure of five lbs. per inch of steam, is supplied with a blowing cylinder of 108 in. diameter, it will be capable of keeping up a blast at a pressure of 2½ lbs. per square inch; for it is calculated that the pressure in the steam cylinder of such an engine, deducting the friction, is about 10 lbs. per square inch. This pressure may be reduced at pleasure, by working the engine more slowly, or with a lower pressure of steam in the boilers.

Air cannot support combustion until heated to 1000 degrees of Fahrenheit; and, therefore, until it acquires that temperature from being in contact with the heated medium, it must produce an inverse effect; and the nearer it can be brought to that point before entering the furnace, the better. The diameter of the blast-pipes at the twyeres is various, according to circumstances. With a strong pressure of blast and three twyeres, a diameter of $3\frac{3}{4}$ in. may be considered a maximum. The greater the quantity of blast that is introduced, the greater generally will be the quantity of iron produced.

To the iron-stone, or *mine*, is added a proper supply of coke to keep up the necessary combustion, and a portion of limestone to act as a flux. The *mine* in South Wales is the argillaceous or clay iron ore, occurring sometimes in strata, sometimes in detached lumps or balls. The *mine* contains different proportions of iron in different parts of the South Wales district. What is generally used may be stated to contain from 18 to 55 per cent., before it has been calcined or roasted. Carbonic acid and clay enter largely into the composition of the ore; and water, sulphur, silex, and perhaps a little arsenic, complete the list of ingredients. To get rid of the impurities before the *mine* is used in the furnace, it is roasted or calcined in kilns, which are kept supplied at the top, as the mine is withdrawn. Care must be taken in this process to give the necessary degree of heat to the kiln, and no more. If there be too much heat, the pieces of *mine* partially melt and adhere together; if too little, they still contain a portion of water or sulphur, and are obliged to be thrown aside by the *filler*, or workman at the tunnel-head, as *raw* or *green* mine. In roasting, there is a loss of weight of 20 to 30 per cent.

*Coke* is of great importance in the smelting of iron. A ton of coal will produce about 13 or 15 cwt. of coke. The method of coking in Wales is to place the coal in long open heaps, containing 30 or 40 tons, laying the pieces of coal as loose and open as possible, to allow of their swelling, and covering the whole with smaller pieces, so as to give the external surface a tolerably level appearance. The heap is then set on fire in different places, and suffered to burn till the whole surface is completely ignited in five or six days. When this is the case, the coker covers it entirely over with the dust and ashes of former fires, to exclude the air and prevent waste, and it is left to burn out, or cool gradually. The cooling is generally, however, expedited by pouring water upon the cokes before they are uncovered, and is found to improve the quality of the coke, by making it harder, and expelling more of the sulphur. The coal, when coked, has parted with all its moisture, tar, and hydrogen gas, and a great part of its sulphur; and, according to its properties, is either of a dull jet black, with the appearance of charcoal, or exhibits a bright metallic or vitreous lustre, with a porous texture. The more carbonaceous matter it contains, the better; and those beds of coal are therefore the most esteemed which present in the fracture the dull soft appearance of carbonized vegetable matter.

Coke is a substitute for charcoal in the smelting of iron. Charcoal is at present in general use in Russia and Sweden, and is used at a few works in this country. The iron produced from it is particularly calculated for conversion into steel; but its high price and insufficient quantity totally preclude its general use. Furnaces are invariably situated on some natural steep declivity.

The *limestone*, the remaining ingredient, is brought to the tunnel-head, where it is broken into small pieces, that it may mix more intimately in the furnace with the mine and coke. It is used as a flux, combining with the clay of the ore, and forming with it a fusible compound, which runs off below in a slag or cinder. In the selection of limestone, all those beds which contain magnesia are sedulously avoided. About a ton is required to a ton of iron.

The materials are introduced into the furnace at the tunnel-head by the filler, whose business it is to see that the coke is brought to him from the coke-hearth properly burned; that the mine is sufficiently calcined and unmixed with clay or rubbish; that the limestone is broken small enough; that the proportion of each material, as directed by the keeper or manager, is maintained; and also to take an account of the number of charges that he puts into the furnace during his '*turn*' of twelve hours. A charge is one barrow of coke, with its proportion of mine and limestone; and the furnace is said to drive fast or slow, according to the number of charges required to keep it full during the twelve hours. The barrow of coke contains about twenty cubic feet, and weighs about six cwt. It is, therefore, the product of about nine cwt. of coal. The proportion of burnt *mine* used to the charge varies considerably, according to the working of the furnace, and the quality of the iron wanted to be produced. If foundry-iron is wanted, the '*burden*' of mine to the charge must not be so heavy as when forge pigs are to be made. The greater the quantity of mine used to the charge, the warmer, and the more disposed to burn, as it is called, the furnace becomes.

The iron is run from the furnace every twelve hours, at about five or six tons. If it is driving 50 charges a turn, with a burden of 6 cwt. of mine, the quantity of burnt mine to make 6 tons of iron will be 50 times 6 cwt., or 15 tons, equal to 18 tons of raw mine; so that 3 tons of raw mine are used for the production of one of pig-iron. The coke for the turn, reckoning 9 cwt. of coal to the barrow, (or 6 cwt. of coke) will, in the same way, amount to 50 times 9, or 450 cwt. = 22½ tons, or 3 tons 15 cwt. to the ton of iron. A further quantity is used at the mine-kilns and engine-fires, which will amount to 4 tons 15 cwt. of coal to the ton of iron. Hence, the daily consumption of a single furnace amounts to 57 tons of coal, and 36 of mine.

The hole through which the iron is let out is on a level with the bottom of the hearth, and in front of the furnace, and it is stopped with a mixture of sand and clay, to prevent the escape of the iron between the times of casting.

There is also an aperture level with the top of the hearth, by which the liquid scoria or cinder is constantly running off, except immediately after casting. The iron, being much heavier than the cinder, sinks to the bottom of the hearth as it is melted; whilst the cinder, forming much more rapidly, soon fills the hearth and escapes. The appearance of the cinder is constantly watched by the keeper, as an indication of the working of the furnace, and he can generally tell, with tolerable certainty, the quality of the iron he is about to cast, by this criterion. The most favourable aspect of the cinder would be that of a perfect glass, indicating neither the presence of iron by the black colour, nor the excess of the flux by the stony opaque appearance of the fracture.

The weight of the materials put in is 36 tons in the twelve hours, whilst the iron produced in the same time weighs only 6 tons. The weight of the cinder will not, however, by any means, balance the account, it being found that there is a loss of weight, in the process of smelting, greater in amount than the quantity of coke used; that is, from 36 tons of materials put in at the tunnel-head, the total produce at the bottom in cinder, iron, and ashes, does not exceed 20 tons. The deficiency is in the combustion by the escape of oxygen, carbon, &c. from the mine and limestone, as well as from the coke.

The pig-iron thus produced in the operation of smelting may be divided, first, into foundry-iron and forge-iron; the former being used in the state of pigs, for re-casting; the latter being applicable to the manufacture of bar-iron.

Of *Foundry-iron*, there are three qualities—first, second, and third.

No. 1, foundry-iron, differs in its chemical composition from the other sorts, by containing more carbon. It is, indeed, combined with as much carbon as it is capable of holding; and, to effect this combination in its full extent, the coke containing the fibrous appearance of charcoal, or the purest carbon, is selected. The tendency of this combination is to render the iron soft, and to make it very fluid when melted, so that it will run into the finest and most delicate mouldings. It is used for small and ornamental castings, and anything that requires a minute and perfect adaptation to the shape of the mould.

When it is highly carbonized, the pigs and the cinder are frequently covered with small bright black laminæ, of a substance called kish. It is a pure carburet of iron, or black-lead, and evinces an excess of carbon in the pig.

No. 2, foundry-iron, is less carbonized than No. 1; not so soft, closer grained, and more regular in the fracture, not so fluid when melted, nor so smooth on the face of the pig; it is, however, harder and stronger, and is preferred for all the less delicate parts of machinery, where strength and durability are required.

These two sorts are all that are recognized, in some places, as foundry-iron. Their being combined with so large a dose of carbon, renders them unfit for remanufacture into bars; but iron of the next quality, or No. 3, having less foreign admixture in its composition, is destined indifferently for the forge or the foundry. It is used extensively for castings where great strength is required, or in situations where it is to be exposed to constant wear and tear, such as tram plates, heavy shafts, and wheels, cylinders for steam-engines, and many descriptions of heavy work. From its appearance, it is often called dark-grey iron, and it has three varieties.

*Bright Iron* is never called foundry-iron, although used extensively for large castings. It possesses great strength and hardness, but not fluidity enough to adapt itself to intricate or minute mouldings.

*Mottled* iron is used exclusively for the purposes of the forge, as it is too thick and brittle for the foundry.

*White* iron is supposed to contain a very small portion of carbon—less than any other sort of pig-iron. It is totally unfit for casting, and is sometimes so thick as hardly to run into the pig-moulds, although they are purposely made very large; and so brittle, that the largest and most unwieldy pigs may be readily broken by a blow with a sledge-hammer.

*Pig-iron* is commonly supposed to be a combination of the pure metal with carbon and oxygen; bar-iron is the same metal freed from these impurities. The operation of refining the pig-iron is performed in small, low furnaces, called refineries. They are about three feet square at the base in the inside. The bottom of the hearth is of fire-brick, and the front, back, and sides, of cast-iron. The castings used for the sides are made hollow, and so contrived as to allow the passage of a constant stream of water through them. This contrivance is necessary, as a precaution against the intense heat of the fire, which would otherwise soon destroy the sides of the refinery. Near the top of this square are three holes in the side, for the introduction of the blast-pipes.

The refinery is furnished with iron doors at the back, but is open in front; and the heat thrown out is too great for any one but the workmen, who are accustomed to it, to come near.

There is a hole at the bottom of the hearth in front, for running out the metal, similar to that in the furnace. It communicates, by a short channel, with an oblong flat mould of cast-iron, about 20 feet long by 2 broad. This is placed over a cistern of water, with the surface of which it is in contact. The process of refining consists in separating a portion of the carbon from the pig, and thus reducing the iron to a greater degree of purity preparatory to the subsequent operations. This is effected by keeping the pigs in the state of fusion for some time, exposed to a very great heat and a strong blast.

From an actual trial, the following results were obtained :—

| | *tons.* | *cwt.* |
|---|---|---|
| Pigs used - - | 151 | 7 |
| Refined metal produced | 135 | 0 |
| Loss | 16 | 7 |

The refinery cinder produced was 31 tons 4 cwt., which would contain rather more than 50 per cent. of iron. The quantity of coal used to the ton of metal is ten or twelve cwt.

The *forge* consists of a hammer and two pair of rollers, or *rolls*, with a pair or two of strong shears to cut the bars. The mill contains two pair of rolls of fourteen inches diameter, for making large sizes of bolts and bars; two pair of ten inches, as an intermediate size; and two or three pair only seven inches in diameter, for rolling the smallest sizes of iron. The mill also, as well as the forge, should be provided with strong shears, for cutting bars. If nail rods are required to be made, there must be the proper machinery for them also—viz. a pair of rolls and a pair of slitters, as they are called. To conclude, a heavy and powerful lathe is necessary, for the purpose of turning the iron rolls. The engine then will be required to put in motion nine pair of rolls, the hammer, shears, and lathe. To effect these objects, an engine with a steam cylinder of forty-five inches will be required. The work to be done by this engine is of a peculiar kind; the strain, or the force and friction to be overcome, being at times very great.

To meet great and sudden strains, that come at intervals, and last for only a short time, the fly-wheel becomes eminently useful. In engines of this description, therefore, it is made unusually large and heavy, weighing 8, 10, or 12 tons, and of the diameter of 16 feet, the weight being disposed as much at the circumference as is consistent with the strength of the wheel. The speed at which it is propelled is also much greater than in ordinary cases, being 70, 80, and even 100 revolutions in the minute. So irresistible is its power, that, in case of any sudden impediment, too great for the machinery to surmount, some part of it must give way, and, as these cases will sometimes occur, it is contrived to make a subordinate part of the machinery weaker than the rest, as a sort of *power valve*, so that, by breaking, it saves the more valuable parts from injury, and is itself easily replaced.

As may be supposed, all the machinery of a forge is obliged to be particularly firm and strong. Very heavy cast-iron plates are embedded in masonry underground, to form a firm foundation. The rolls are cast solid; and to provide for the great and constant wear they have to sustain from the pressure of the bar, as it passes through them, they are made of bright iron, as being the hardest quality that is consistent with a proper degree of strength.

From what has been stated of the number of shafts and wheels in the machinery of a forge and mill, each of which must have its axles or bearings, it may be supposed that the friction to be overcome is of itself enormous. It is increased from the necessity of all these axles and bearings being large and strong; and the only means there are of keeping it at all within bounds are therefore anxiously resorted to. The first of these is to have all the machinery constructed and put together with great accuracy. The next is to have brass bearings for all the necks of the rolls, the axles of the wheels, and the ends of the shafts,—the friction occasioned by the rubbing of two different metals being well known to be much less than that of two pieces of the same metal. The third is, to keep all the points of friction well oiled and perfectly cool. If the axle of a wheel or neck of a roll be suffered to become hot, the friction is prodigiously increased at once.

The first grand process at the forge is the puddling, an operation by which the oxygen and carbon are still further and more completely separated from the iron than could be accomplished in the refinery. It is performed in a reverberatory furnace, called a puddling furnace. The chimney is carried up to the height of 30 feet, and bound together at different points with iron, to keep it firmly together. There is a damper at the top of it, by which the puddler regulates the degree of draft (and consequently heat) to his furnace; for, during some parts of his operations, he wants a more intense heat than at others. The draft and heat of these furnaces are so great, that the flame is carried completely through to the top of the stack, where it comes in contact with the damper, which is frequently nearly red-hot. The bottom of the furnace was formerly always composed of sand, and occasionally is so still; but the most general plan is to construct it of a thick cast-iron plate, which is preserved from fusion by a coat of the oxide of iron or cinder, that is formed in puddling. The furnace, when first lighted, requires three or four hours before it is ready to be charged, or to receive a heat of metal, as it is called; that is, the proper quantity of refined iron. The general weight of the charge is about 3½ cwt., or from that to 4 cwt.

The metal being all put into the furnace, the door is shut down and carefully closed, to prevent the admission of air; as any air admitted, except through the body of the fire, tends to lessen the heat and derange the regular circulation of the current. When the whole is melted, the puddler, sometimes with a tool turned at the end like a hoe, and sometimes with a flat one, stirs it about diligently in all directions, exposing every part of it in turn to the action of the flame. In doing this he is obliged constantly to change his tools. The liquid mass heaves and boils whilst it is being stirred, showing the escape of an elastic fluid. After a time, it becomes more and more thick, having a sort of curdy appearance as it is turned over, the points and corners of the small crumbs being of a bright glowing white heat, whilst the body of the mass looks cooler. When the iron is in this state, the workman says "*it is coming round to nature.*" The puddler still perseveres in stirring, or rather moving it about, till it is so thick and tenacious as to stick together and form into lumps. He then begins to "*ball it up*;" that is, to divide it into a certain number of portions, generally five or six, which he brings into a round form with his tools, making them as firm and compact as he can. In this state they are called puddler's balls or blooms, and the puddler has now finished.

When the puddler has completed all his balls, his underhand proceeds to deliver them over to the shingler, or the roller; for, in some works, the process of shingling is omitted, the puddled ball being rolled at once into the rough bar. The shingling consists in giving the puddled balls a few blows with a very heavy hammer, which makes them more solid, and reduces them to an oblong shape, better calculated for going between the rolls. It also *squeezes out* a portion of the liquid cinder or oxide, which is separated from the pure iron in the puddling. The hammer generally weighs about four tons. Six little projections or arms in a solid wheel raise the point of the hammer, and let it fall again in the course of their revolution. From ten to twenty blows are generally sufficient to give the bloom its due form.

The roller takes the bloom from the shingler, and, whilst it is still hot, passes it through the puddle-rolls. It is first put through the largest hole in the rolls, and then goes through the smaller ones in succession. It is received by a boy on the opposite side, called the catcher, and handed back by him, with a pair of tongs, over the rolls, to the roller, who, when he has reduced the size of the bar in the first pair of rolls, passes it through different grooves of the second. There it is reduced to a more accurate form, and to the required width and thickness.

The iron is now in the state of a rough bar. The metal that was put into the puddling furnace was easily fusible, very hard, and very brittle; it has now become a long slender bar of malleable iron, soft, tough, and hardly fusible; and this great change, it is supposed, is effected merely by the separation of a little oxygen and a minute portion of carbon from the pure iron. It has still to undergo a further purification at the mill.

Twenty-two cwt. is about the usual quantity of metal required to make a ton of rough bars, supposing the puddler is allowed to use little or no cinder; and about 17 cwt. of coal is consumed to the ton of rough bars.

The rough bars, when they come from the puddle-rolls, are cut into lengths by a strong pair of shears, worked from the engine. They are of such sizes and cut into such lengths as are best adapted to the size of the finished bar wanted. They are generally 2, 3, or 4 inc. wide, by ½ or ⅝ths of an inch thick. These are wheeled to the balling or heating furnaces, and delivered to the pilers.

The construction and shape of the balling furnace is very similar to the puddling furnace. It is a reverberatory furnace, heated by a coal fire at the end, the flame of which is drawn on by the current of air, and turned downwards, in its course to the flue, by the inclination of the interior of the roof.

Its use is simply to give a welding heat to an oblong pile of the rough bars, which are then to be reduced by the rolls to the shape of finished bars.

The business of the pilers, generally boys or women, is to pile up or place together the lengths of the rough bars, which are delivered to them from the shears. The pile generally consists of five or six of these pieces, laid evenly one upon another, all being of the same length, so that one does not project beyond the rest. The post of the baller is not one of great labour, but it requires considerable experience, attention, and care. The point of time when the piles in his furnace are just ready for the roller, is a most critical one. If he takes them out too soon, they are not completely welded together, and do not make a smooth and compact bar; and, on the other hand, every minute that they are allowed to remain beyond the proper time is productive of injury.

The waste in the balling furnace is considerable, and, unlike the puddling furnace, the greater part of the cinder runs off the pile in the furnace, and thus separates itself from the iron without mechanical force.

With the large sizes the yield is better: that is, the waste is less than with small iron; for, as has been seen before, the loss in the furnace is proportionally greater as the size of the pile is smaller. With the ordinary sizes of bars, as they occur in the large rolls, the loss is about $1\frac{3}{4}$ cwt., a ton of finished bars being produced from $21\frac{3}{4}$ cwt. of rough bars. With the smaller sizes the loss is above 2 cwt.; so that, to take all the sizes of bars as they are produced, the loss is about $2\frac{1}{4}$ cwt. on the average.

The last operation in the manufacture of bars is the rolling. The variety of sizes is very great, but they may all be divided into three heads: rounds or bolts, squares, and flats. For these there are three pair of rolls; the first for round iron, the second for squares, and the last for flats. These are what are called the finishing rolls, for before the pile is brought to them, it is reduced to a size somewhat approaching to that required, by the roughing rolls, which are larger than the finishing rolls, and provided with wider grooves. The pile is passed through several of these, each rather smaller than the preceding one, and by this means reduced from its original form to that of a solid bar, the various layers of which it is formed being firmly welded together, and the remaining portion of cinder and impurity being thoroughly expelled.

There is a sort of rest, or small bench, in front of the roughing rolls, to support one end of the bar, whilst the roller holds it by the other in his tongs, and pushes it through the grooves: it is received by a man on the other side, called the catcher, who returns it over the top roll. It is handed backwards and forwards with as much expedition as possible, that it may not cool.

There are generally three sizes of rolls; the largest, about 14 to 16 inches diameter, the middle 10, and the small rolls 7—and to produce the same speed to the bar in passing through these different-sized rolls, they must of course be made to revolve more quickly in proportion as the circumference is decreased. But this is not all that is necessary, for the small iron is required to be rolled at a greater speed than large sizes, as it becomes cold so much sooner. About 70 revolutions a minute are considered a good speed for the large rolls, 140 for the middle-sized rolls, and 230 or 240 for the small ones, which will be found, on calculation, to give them a considerably greater velocity than the others. After being rolled, all that remains is, that the bars have the ends cut off by powerful shears, worked by the engine, when they are ready for shipment. They are, however, previously straightened by boys, on a long bench of cast-iron, and stamped with some letter or device, to distinguish the works where they are made.

The following are the principal results obtained by M. Lagerhjelm, with great care, and the use of a very complete and powerful apparatus:—

1st. Rolling always gives the same iron the same uniform density. Hammered bars of the same iron are often of different densities, and frequently contain scales.—2d. Rolling does not twist the fibre of the bar: hammering sometimes does.—3d. The measure of elasticity is the same for both hammered and rolled bars; but the limit of elasticity (measured by the greatest weight which the bar can support for a given sectional surface, without any permanent change of form) is greater for hammered than for rolled bars, if neither have been refolded; but if they have been refolded, the limit of elasticity is increased, and becomes the same for both.—4th. Rolling gives more ductility to iron than hammering.—5th. Cohesion appears independent of the process employed, and is the same for both. —6th. The lengthenings and shortenings (both of which follow the same laws) are not proportional to the forces which draw or compress a bar of iron in the direction of its length.—7th. Elasticity is not changed by tempering.—8th. Very different forces are required to produce the same permanent change of form in a brittle and a soft iron.—9th. The limit of ductility being taken as the length which a bar a foot long will increase by, from the state of unaltered elasticity until the moment of rupture, the most ductile iron experimented with was found to give, for its limit of ductility 0·27 of the original length, and 0·722 of the original section.—10th. The cohesion is the same for brittle or soft iron, fibrous or not fibrous: so that the absolute strength of iron appears to depend upon its ductility.—11th. The volume of the metal increases as the bar is drawn apart; and the specific gravity of the iron at the broken surface is less, nearly by 0·01, than that of the same iron taken from an unaltered part of the bar.—12th. When the iron is extended, preparatory to its fracture, heat is evolved; the heat is greater for soft than harsh iron. Sometimes a bright spark appears at the moment of rupture.

The quantity of pig-iron required to make a ton of bars, in the different stages of the manufacture, is as follows: The *refinery* is the first of these; and the yield of pig-iron to the ton of metal is from 2 to 3 cwt. and we will therefore assume as an average that 22½ cwt. of pig is taken. The next stage is the *puddling*, in which we will say that 21½ cwt. of refined metal is consumed for the production of a ton of the rough bars. 22 cwt. was before stated as the average puddler's yield, but this was on the supposition that little or no cinder is used, and for common iron a pretty free use of cinder may be allowed. But the 21½ cwt. of refined metal will be found on calculation to be equal to 24.188 cwt. of pig-iron; and this is, therefore, the yield of pig-iron to the ton of rough bars. The third and last process in which there is a waste of the material is the *balling*, and here it was stated that the waste per ton was about 2¼ cwt., which we will, therefore, take as an average. By pursuing the calculation, we shall see that supposing one ton of rough bars equal to 24·188 cwt. of pigs, 22¼ cwt. of rough bars will be equal to 26·909 cwt. of the pigs, which will be the quantity necessary for the production of a ton of bar-iron.

Thus, when reduced from decimals to quarters and pounds, will be 1 ton. 6 cwt. 3 quars. and 19 lbs., or a loss of one-third from the furnace to the finish. The total consumption of all the materials, supposing 4¾ tons of coal to be used at the furnace for the ton of pigs, including the engine and mine-kilns, the 1·345 of pig-iron will require 6·378 tons of coal. In addition to this, we have to take the consumption of coal at the refinery, the puddling-furnace and the balling-furnace, including what is used at the forge-engine.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st... | 6·378 tons of coals at furnace | | | | | |
| 2dly. | ·611 | ,, | ,, | refinery | | |
| 3dly. | 1·9 | ,, | ,, | forge & mill | | |
| | —— | | *tons.* | *cwt.* | *qrs.* | *lbs.* |
| Total | 8·889 | .. or | 8 | 17 | 3 | 3 |

of coals consumed in making a ton of bars. Then three tons of mine being assigned as the yield to the ton of pigs, 4·035, or rather more than four tons, will be the amount required as the yield of iron-stone to finished bars. In the same way, supposing 21 cwt. of lime-stone is used to the ton of pigs, 1·415 will appear as the proportion of lime-stone to bars.

It will be seen, from the foregoing observations, that, in the manufacture of foundry-iron, the great object is not to produce pure iron, but a compound of iron with carbon; and the greater the proportion of carbon, the better will be the quality of the pig. In wrought-iron, on the contrary, the aim is, to attain to the greatest possible purity, any admixture of a foreign substance being found disadvantageous.

In the year 1825, the current price of common bar-iron, at the shipping port, was 14*l.* per ton; and, in 1832, the same article sold for 5*l.* and 4*l.* 10*s.* per ton.

Iron-works are establishing rapidly in North America and elsewhere. And the Welsh and Staffordshire iron-masters were lately employed, to their own destruction, in the execution of castings, &c. for a very large establishment that is forming under the auspices of a public company in France, at Alais, in Languedoc. The iron-stone and coal ore are said to be of excellent quality and most abundant—so much so that it is anticipated that pig-iron will be made there at half the price that it can now be manufactured at in Great Britain.

*Comparative Quantities of Iron manufactured in Great Britain at different periods.*

| | *Tons.* | *Furnaces.* |
|---|---|---|
| 1740 .. | 17,000 .. | 59 |
| 1788 .. | 68,000 .. | 85 |
| 1796 .. | 125,000 .. | 121 |
| 1806 .. | 250,000 | |
| 1820 .. | 400,000 | |
| 1827 .. | 690,000 .. | 284 |

*Proportions in which it was produced at the different Iron Districts.*

| | *Tons.* | *Furnaces.* |
|---|---|---|
| South Wales .. | 272,000 .. | 90 |
| Staffordshire .. | 216,000 .. | 95 |
| Shropshire .... | 78,000 .. | 31 |
| Yorkshire ..... | 43,000 .. | 24 |
| Scotland ...... | 36,500 .. | 18 |
| North Wales .. | 24,000 .. | 12 |
| Derbyshire .... | 20,500 . | 14 |

Of this quantity three-tenths is calculated to be foundry-iron.

The iron smelted is *carbonate*; the next carbonate is black cast, of 3 atoms of iron to 1 of carbon; white cast of 4 iron, 1 carbon; and cast-steel of 20 iron, 1 carbon. The equivalent of iron is 28 and of carbon 6. Hence steel is 566.

The common red rust of iron is a peroxide, or 2 iron and 3 oxygen. The black rust or smiths' scales are protoxide of iron and 1 oxygen.

Hemalite is 1 of the peroxide and 1 of water.

Pyrites is a bi-sulphuret of iron, consisting of 1 atom of iron (28,) and 2 atoms of sulphur (32.) It is a brittle, yellow, metallic substance, with 4·5 sp. gr. Heated in the air it takes fire, and the sulphur evaporates. There are five sulphurets of iron.—Sulphuret 1 atom iron to 1 sulphur, then 2 and 3, 1 and 2, 2 and 1, and 4 and 1.

Black oxide of iron is the lowest oxidation. Red the highest.

Iron is four times the strength of oak, and six times that of deal.—*Ure.*

*Heated air* is applied in some ironworks. Where this method of working the ore has been introduced, the air is blown by cylinder-bellows in the usual manner, but before entering the smelting-furnace it passes through pipes of cast-iron, heated to redness, which are altogether about thirty feet in length and three feet in diameter. They are usually made in three or four pieces, joined together by apertures considerably less than three feet in diameter, and placed horizontally, or in whatever manner the local arrangements about the furnace may render most convenient. A brick arch is then thrown round the pipes, leaving a free space of about eight inches, and upwards, between it and them, and two or more furnaces constructed, so as to heat the pipes in the archway, the flues playing into it, and terminating in a common vent at the farther extremity. They may be considered, therefore, as placed on the floor of a long and narrow reverberatory furnace, about six feet high, and nearly of the same breadth, being at the same time protected by fire-bricks, when they might be injured by the direct flame of the furnaces. The iron ore is smelted, according to this plan, with little more than half the coal necessary when the furnaces are worked with air in the usual manner; the small coal, which is sold at an inferior price, is found quite sufficient for heating the pipes.

*Iron guns.*—Pig-iron of gray colour should be melted in an air-furnace with an intense and rapid fire, for iron guns; but an alloy of copper and tin is used for brass guns. The first are used on ship-board and the latter for field-artillery, with a bush of copper, as less fusible by firing, for the touch-hole.

The solid casting is then bored by the revolution of the gun, with an apparatus and steam-power. A 24-pounder of iron is 10 ft. long, and weighs 52 cwt. with a bore of 5·824 inches. A ball of 5·547 inches and 8 lbs. of powder. A 24-brass-powder weighs 50 cwt. An iron 6-pounder weighs 24 cwt. and is 9 ft. long.

The following is the comparative power of a few different metals, to sustain weights by suspension, according to Mr. Rennie's experiments, in bars one quarter of an inch square:

| | *lbs.* |
|---|---|
| A cast-iron bar, hor. sustained | 1166 |
| A ditto, vertical - - - | 1218 |
| A cast-steel bar, previously tilted | 8391 |
| A blister-steel bar, reduced by hammering - - - - | 8322 |
| A shear-steel bar, ditto - - | 7977 |
| A Swedish iron ditto, ditto - | 4504 |
| An English iron ditto, ditto - | 3492 |
| A hard gun-metal bar - - | 2273 |
| A wrought-copper bar - - | 2112 |
| A cast-copper ditto - - - | 1192 |
| A fine yellow brass bar - - | 1123 |
| A cast-tin bar - - - - | 296 |
| A cast-lead bar - - - | 114 |

*To render Iron fusible.*—Heat a bar red-hot, hold it over a vessel of water, and touch it with a roll of sulphur. This will make the iron fall in drops into the water. Then pick up the drops in the bottom of the vessel, and, preferring the heaviest, they are iron which will melt for any purpose with less heat than melts lead.

*To reduce scales of iron.*—Fuse them in a crucible lined with charcoal at a great heat, for an hour, and spongy but pure iron will result.

*To make sulphate of iron.*—Digest 4 iron wire, 7 sulphuric acid, and 60 water, so that the metal may be dissolved. Filter through paper, evaporate, and set to cool and crystallize. It is useful in diabetes and phtisis, from 1 to 5 grs.

*To make dried sulphate of iron.*—Heat sulphate of iron in an unglazed vessel, slowly, till it becomes white and dry.

*To make red oxide of iron.*—Expose dried sulphate to an intense heat till it becomes red.

*To make tartarized iron.*—Rub together 1 iron-filings, 2 super-tartrate of powdered potash, 1 water. Expose them to air 15 days, daily stirring and adding water. Boil in four times the weight of water. Evaporate, dry, and powder. Put in stopped bottles.

*To make acetate of iron.* Digest one part of carbonate of iron in six of acetic acid for three days, and filter.

*To make carbonate of iron.*—Dissolve 4 oz. of sulphate of iron in 10 lbs. of water, in which previously dissolve 5 oz.

of subcarbonate of soda. The carbonate of iron is precipitated. Wash and dry it.

*Steel* is made by putting bar-iron, generally Swedish, into fire-stone boxes, with alternate layers of charcoal, and exposing them for eight or ten days to a red heat, by a process called *cementation.* They then come out carbonized as *blistered steel.* This is then fused in a crucible, and cast in bars as *cast steel.* It is then broken into pieces, and exposed for some hours to the greatest heat, so as to be fused and cast again. The best steel in England, and perhaps in Europe, is made by Sanderson and Co. of Sheffield.

*Blueing iron and steel.*—Iron and steel articles, when their surfaces are polished, whether simply by the file or by rubbing with emery, putty of tin, &c. are susceptible of receiving a *blue colour* from the action of heat. In a stove made of sheet-iron, they place turfs, made of spent tanner's bark, or merely dried tan, and these are covered with lighted charcoal-dust. The fire soon communicates to the turfs, or tan-dust; when these begin to burn, they place the pieces intended to be blued upon them, taking care that the ashes do not cover them, in order that they may see the colour which they assume. It is requisite to be very careful that the heat be uniform, and that it be retained at exactly the same degree, without being too great; as, in that case, the operation would fail entirely, and the blue colour soon disappear, and turn to a gray; the article would also lose its hardness; it must be hardened afresh, and there would be a very great chance of its being over-heated. We should, therefore, prefer a fire less active, and operate by degrees. When well-polished steel has acquired a red colour, and it is seen that this colour is not perfectly uniform, the greatest heat must be directed towards the part where the colour is least intense, by blowing with the mouth that part of the fire adjacent to it. By this means, with care and patience, a beautifully-uniform and deep blue colour is obtained. When the article has become of a red colour, if it is found to be clouded with various shades, it is better to suspend the operation, and polish the article afresh, either with emery, tripoli, *crocus martis*, putty of tin, &c. and entirely to begin anew, rather than expose the article to too great softening. When it has acquired the desired colour, it is withdrawn from the fire, and allowed to cool slowly, when it must be wiped with a clean, dry, linen cloth. Particular care is required not to touch the articles, when finished, with greasy or damp fingers; but, above all, not to dip them in oil, as they would become dull, and lose that lustre in which consists all their beauty. This blue colour remains for a long time: nevertheless, it is subject to change; in which case it may be restored to all its freshness by the article being polished anew, and again submitted to the same operation. Iron never takes so fine a blue as steel, as it does not receive so good a polish, neither is it so hard; and it is probable that the carbon contained in the steel has some influence on this operation.

*To preserve iron from rust.*—Eighty parts of pounded brick, passed through a silk sieve, mixed with twenty parts of litharge: the whole rubbed up by the muller with linseed-oil, so as to form a thick paint, which may be diluted with spirits of turpentine.

Iron, in gasometers, is preserved by the coal tar. When at a dull red-heat, it is preserved by dipping it first in water and then directly into linseed-oil.

*Iron wine.*—Digest one month 1 oz. of iron filings in a pint of sherry. *Or*, Seven days 1 oz. of iron filings in a pint of rhenish. A dose of 2 to 6 drs. twice a day is tonic; but it should not be used in full habits or bilious affections, but it is highly beneficial to languid or weakened constitutions.

*Iron filings*, which have been tested as such by a magnet through a sieve, are useful, when debility is accompanied by acidity in the stomach. Black stools and offensive belchings are evidence of their utility. Mixed with honey, or some aromatic paste, the dose is from 5 grs. to ½ dr. Blacksmiths' scales, tested as above, produce less wind, and are often preferred.

A lb. of black wadd, or ore of manganese, mixed with a quarter of linseed-oil, inflames in half an hour. The oxygen of the manganese combines with the hydrogen and carbon of the oil. So also iron filings and sulphur, made into paste with water, 50 lbs. of each, and buried, send up vapours, and finally take fire and explode with volcanic characteristics.

ISINGLASS, *(fish glue,)* is principally prepared from the sounds (air-bladders) of the beluga and sturgeon, by scraping, steeping in lime-water to remove the grease, washing, drying, twisting into staples, bending into a book, or rolling into a ball. It is used to fine wine and beer, and to make jelly. 6 grs. grow solid with half a pint of water.

*Caviare* is the spawn of sturgeon and some other fish, broken by the hand, mixed with salt and dried. *Red caviare* is the spawn of fish, salted and smoked.

ITCH, a very annoying disease, arising from insects in soft parts of the skin, is cured by an ointment of four parts hogs'-lard, and one flowers of sulphur.—*Or*, by gentle heat and rubbing, mix

8 lbs. of hogs'-lard, 14 oz. of Venice turpentine, 1 lb. of corrosive sublimate and of acetate of lead, 8 oz. of sal ammoniac and of alum; colour with cinnabar, and scent with essence of lemons.—*Or, (Edinb.)* In 2 lbs. of hogs'-lard mix 2 lbs. of milk of sulph. and 1 lb. of black pitch.

IVORY, is the tusk or tooth of defence of the male elephant. It is an intermediate substance, between bone and horn, not capable of being softened by fire, nor so hard and brittle as bone. Sometimes it is an enormous size, weighing nearly 200 lbs. It is of a yellowish, brownish, and sometimes a dark brown colour on the outside, internally white, hollow towards the root, and so far as was inserted into the jaw, of a blackish brown colour.

It is used for making ornamental utensils, mathematical instruments, cases, boxes, balls, combs, knife-handles, dice, and toys.

Guillot obtained from 100 parts of ivory, 24 gelatine, 64 phosphate of lime, and 0·1 carbonate of lime.

Ivory is restored in colour, by covering it with quick-lime and pouring vinegar on this. After 24 hours rub it with alum-powder. The best ivory comes from Ceylon.

Ivory Black is made by exposing ivory and bone-shavings in an iron cylinder, at a red heat, allowing the effluvia to rise through a pipe.

IVY-LEAVES, are used internally in atrophy, and to dress issues. The berries purge, and the trunk yields gum.

JACK, is the name of a very powerful machine for raising great weights. Its ordinary power is 5 tons, or 200 times the force of man applied to the handle. The better sort are supplied with a ratchet, to prevent their running back.

JACK is also the name of a kitchen-machine for cooking, and the moving power is either a weight or the smoke and rarefied air of a chimney. It has a worm, or endless screw, with a main-wheel of 60 teeth, a worm-wheel of 30, and a pinion-wheel of 15.

JADE, the true *lapis nephriticus*, seems to belong to the siliceous order; as it gives fire with steel, and is semi-pellucid, like flint; it does not harden in fire, but melts, in the focus of a burning lens, into a transparent green glass with some bubbles.

It contains ·47 silex, ·38 carbonate of magnesia, ·04 alumine, ·02 carbonate of lime, and ·09 iron.

Its spec. gravity is from 2·950 to 3·389.

The semitransparency, hardness, and specific gravity, are the characters by which the *lapis nephriticus* may be distinguished from other stones.

JALAP, *(convolvolus,)* is a Mexican plant, whose root is a powerful cathartic. The root is very large, as 40 or 50 lbs., and filled with white juice. When dried and powdered, it dissolves in water and alcohol, and its properties depend on a hand and soft resin. The watery extract is pleasantest and most efficacious; and it may be united with calomel or essential oil. The dose is from 10 grs. to ½ dr. in powder or pill. It is used to check the rapid progress of fermentation in molasses' spirits, for which purpose it is strewed over the surface, and common resin will do as well.

JAMES'S FEVER POWDER, is still a nostrum, though the specification of his long-expired patent is as follows:—"Take antimony, calcine it with a continued protracted heat, in a flat unglazed vessel, adding to it, from time to time, a sufficient quantity of any animal oil or salt, dephlegmated; then boil it in melted nitre for a considerable time, and separate the powder from the nitre by dissolving it in water." This resembles an alchemical receipt to make gold, which none could ever follow.

JAMES'S ANALEPTIC PILLS, consist of equal parts of his powder, of gum ammoniacum, and aloes, with myrrh, and mix with tincture of castor.

JAPANNED TEA-TRAYS, were made by Clay, by uniting sheets of paper with wheaten flour and glue boiled together. They were then rubbed with towels, from the centre to the edges, and dried in a stove before another sheet was laid on.

JAPAN, FOR TIN WARE.—In 6 oz. of oil of lavender dissolve 2 oz. of copal and 1 dr. of camphor, and mix with 8 oz. of oil of turpentine.

JAPAN PAINTING, is effected by colours prepared in varnish. It is finished with a coating of seed-lac varnish, made of 3 oz. of clean seed-lac, dissolved in a pint of rectified spirits of wine. This is laid on by single coats, with the brush, and each separately dried to the number of five or six coats. It is subsequently polished with a rag dipped in powdered rotten-stone and finished with oil. In white grounds, fine putty or whiting should be used.

JARGON.—A hard gem brought from the East Indies, in the form of thin plates, which appear to be split from pebbles. They are of different colours, white, black, yellow, and brown, about as hard as sapphire; and as they have a great resemblance to the diamond, they are substituted instead of it in jewellers' work. In this stone, Klaproth discovered the earth called zircon.

JASPER, an opaque flint, which resembles dry clay. It is capable of a fine polish, and its colour is generally reddish, or green, or striped; but it is also found blue, gray, or whitish. Its specific gravity is from 2·58 to 2·778.

It is infusible alone with the blowpipe; but it melts with *borax* or *microcosmic salt*, without any effervescence. Fire increases its hardness.

It is composed of *siliceous earth*, united to alumine very full of iron. Daubenton mentions 15 varieties.

JAUNDICE. Cut a ripe lemon in two parts and take out the seeds; procure as much turmeric as will lay on the end of a knife, with about 5 grs. of saffron; put them all in the place of the seeds; then stick some cloves in, and tie the two halves of the lemon together; wrap it in a sheet of paper, and roast it for an hour in pot-ashes. Take off the paper, and steep the lemon in a gill of white wine; afterwards cover it closely, and let it stand all night: in the morning, squeeze the lemon into the wine and strain it off. Drink it off before eating. Twice or thrice repeated, it is quite sufficient for a cure.

JELLY FROM GRAPES. Take the ripest grapes, and spread them on clean straw; at the end of a fortnight pluck them from the stalks, and boil them for five or six minutes, in order to be able to extract the juice with ease: after passing the juice through a sieve, add a ¼ lb. of white sugar to each lb. of juice, and boil for half an hour. Then set to cool; and in 24 hours there will be a fine jelly for invalids.

JERSEY CABBAGE, attains the height of from 4 to 10 or 12 feet. Cows are fed with the leaves, plucking them from the stem as they grow, and leaving a bunch or head at the top. The stems, too, are very strong, and used for fences, &c. and, on becoming dry, are good fuel. The bud or head boiled is particularly sweet. The seed is sown at the end of August.

JESUITS' DROPS. In five half pints of alcohol mix 5 oz. of sarsaparilla-root, 4 drs. of Peru-balsam, and 7 oz. of gum guaiacum.

JET, *lapis obsidianus*, and *fossil-wood*, are often confounded, on account of their black glossy colour. But the lapis obsidianus is volcanic glass, and jet is compact bitumen. It is much harder than asphaltum, always black, susceptible of a good polish, and glossy in its fracture, which is conchoidal. Its sp. gr. is 1·259, and it melts in a moderately-strong heat, with a disagreeable smell.

It is used in the manufacture of small toys, and is an ingredient in some varnishes.

JOURNAL, the support of a water-wheel shaft, the diameter of which, according to Buchanan, should somewhat exceed the cube-root of the weight of the wheel in hundred weights; so that if the weight was 15 tons or 300 weights, the diameter of the journal should not be less than 7·124 inches. Another writer would make it 7⅞.

Shafts or journals of shafts, in wheels of mills and machinery, are, in strength, as the cubes of their diameters by the revolutions in the same time; and inversely as the resistance opposed.

Buchanan states, that the fly-wheel *shaft* of a 50-horse engine, performing 50 rotations per minute, ought to be 7½ inches in diameter, the cube of which 421·9; and he then takes the cube of the next size at half, and of the inferior size at a fourth, *i. e.* the cube-root of 421·9 is 7½ inches; or 211 is 6 inches nearly, and of 105 is 4·7 inches.

Cast-iron will sustain more torsion than malleable iron; but the latter power is only as 9 to 14.

On these principles a 10-horse power, performing 30 revolutions per minute, requires a journal of 5·2 inches, and at 60 revolutions 4·1 inches; and a 30-horse power, at 20 revolutions, a journal of 8·4 inches, or, at 90, 5·2 inches. —*Brunton.*

JUICES OF PLANTS, are extracted by pounding the plant in a marble mortar, and then by putting it into a press. The muddy green liquor requires to be clarified then. But some plants contain so little juice, that water must be added while they are pounded. Other plants, which contain a considerable quantity, furnish but a small quantity, because they contain much mucilage; which renders the juice viscid, and water must be added to obtain their juice.

The juices are a collection of all the proximate principles which are soluble in water. When therefore these juices are to be clarified, some previous preparations must be used. Juices which are acid, and not very mucilaginous, are spontaneously clarified by rest and gentle heat. The juices of most antiscorbutic plants, abounding in saline volatile principles, may be disposed to filtration merely by immersion in boiling water; and as they may be contained in closed bottles while they are thus heated in a water bath, their saline volatile part, in which their medicinal qualities chiefly consist, is preserved. Fermentation is also a method of clarifying juices, which are susceptible of it. But many of them are susceptible only of an imperfect fermensation, and the qualities of most are injured by this process. The method of *clarification* most generally used, and indispensably necessary for those juices which contain much mucilage, is to boil with the white of an egg.

JUNIPER.—The berries of the *juniperus communis* are made use of to impart their peculiar flavour to spirit, constituting *gin*. They aro also used by brewers, to give pungency to the lighter kinds of beer. In some parts of Europe they are roasted, ground, and used as a substitute for coffee. They are also used in Sweden and in Germany as a conserve, and as a culinary spice, and especially to give flavour to sour-crout. They have a decidedly diuretic property, and they are much used as diuretic medicines.

The oil of juniper, if mixed with nut-oil, forms an excellent varnish for pictures, wood-work, and iron, which it preserves from rust. From the bark exudes are sinous gum, known by the name of *gum sandarach.* It is in small yellow pieces, very brittle and inflammable, and of a pungent aromatic taste. When finely powdered and sifted, it constitutes the substance so well known under the name of *pounce.* It is also used by painters in the preparation of varnish, especially of the kind termed *vernix.*

The wood of the *J. Bermudiana* is exported from the Bermudas, and among other uses is employed in the manufacture of black-lead pencils.

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KALEIDOSCOPE, is a pleasing optical toy, invented in the 16th century, and described in books of that time. It consists of two plane oblong mirrors, cemented in a tube, at any acute angle which is an aliquot part of 360°, as 60°, 45°, 30°, 24°, or 18°; and the mirrors, viewed lengthways, display, by their mutual reflections, as many images of any objects at the other end as the angle is parts of 360°. The reflections complete the circle, and various objects exhibit all varieties of colour. For convenience, and to prevent the interference of foreign light, the mirrors are placed in a tube, and protected by an eye-glass, and a double glass for objects at the other end. The completion of the visual circle illustrates the Editor's original theory, that all magnifying is merely the principle of the multiplying glass with the curved or infinite-sided surface of a convex lens.

KALI, a maritime plant, from the ashes of which a considerable quantity of soda is obtained by lixiviation. By boiling the plant in water, and evaporating the decoction, a considerable quantity of sea-salt may be obtained.

KAOLIN, or Porcelain Clay, is dry, friable, and infusible. That of Cornwall used for English china and fine pottery; that of Limoges to make Sevres china; that of Passau for Vienna china.

KEEL, the pieces of timber laid on the blocks, and on which the ship is built; it is generally elm, except the after-piece, which, on account of its being often wet and dry, is sometimes oak, especially when the ship is expected to be a great while in building. The number of pieces in the keel is not very material, so that it gives good shift to the keelson and the main-mast. The keel is scarfed with a hook in the middle, which should lay very close, it being designed on purpose to bear the strain of calking the butts, that the bolt in the scarf may not be strained. The keel should not be tapered much, either forward or aft at the upper part, and from thence it is to be bearded away at the lower edge; for, when the dead-wood is trimmed, especially abaft, being frequently very thin, it is with much difficulty that the dead-wood can be securely bolted.

The speed of a vessel does not depend so much upon the form of the bow as it does on the depth to which it is immersed in the water. In the case of a frigate drawing 17 feet water, and another frigate of the same burthen drawing 11 feet, the last will have a body of six feet less fluid to penetrate, to make her hold a good wind, while the first has six feet perpendicular depth of her hull depressed, being about one-third of her real size. Therefore, she has a body of water to displace, and to force herself through, equal to the difference between 11 and 17. The resistance of the fluid also increases in proportion to the depth. Vessels in the coal-trade draw 1-3d less water than any other of British construction; yet, when employed as transports, they sail as fast as any others; and, before the wind, in ballast, or half loaded, frequently beat the royal navy. When close hauled on a wind they drop to leeward; but, if they were furnished with *sliding keels*, they would be superior to all the other English vessels. The Dutch have vessels built almost flat, but all these have *lee-boards*, by the assistance of which they sail as fast as any that navigate the North Sea.

Ships, or vessels of the larger classes, should always be so constructed as to sail on, or nearly on an even keel, that is, so that when the ship is trimmed for sailing, she should have her keel *parallel* to the surface of the water; therefore, as much as the effort of the wind on the sails and mast, in forcing the ship through the water, has a constant tendency to *depress* the bow, so much should the ship be properly trimmed at the stern.

A sharp-built ship sinks under its cargo so fast, that by the time it comes to its bearings, it is frequently not loaded. Those having flat and long floors, on the other hand, sink slowly; and after having taken in the quantity they measure, will have, frequently, plenty of room, and remain high out of the water. The only objection to the latter is, the unfitness of a flat-floored vessel to hold a good wind, but this difficulty is removed by the adoption of *sliding-keels*. The same principle, which causes flat-floored vessels to sail faster before the wind, to carry a larger cargo, and draw less water, operates with equal force in rendering them easy at anchor. Their form, with the fulness of their body fore and aft, enables them to rise and fall, according to the lift of the sea, while sharp and clean-built ships pitch with the utmost violence, frequently with such force as to endanger the masts; to say nothing of the strain which the tremendous jerks give the hull and the injury of the anchors and cables.

On this plan a king's cutter of 120 tons was launched at Plymouth, in 1791. The length of this vessel is 66 feet, breadth 21 feet, and depth of the hold 7 feet: her bottom is quite flat, drawing only six feet water, with all her guns, stores, &c., whereas, vessels of her tonnage, on the old construction, draw 14 feet. She had, on Schank's plan, three sliding-keels enclosed in a case or well, each 14 feet in length, and the fore and the aft keels 3 feet broad, and the middle is 6 feet broad. They were moveable by a winch, and might be let down seven feet below the real keel. By means of her sliding-keels she kept steady in the greatest gale; was quite easy in a great sea, did not strain, and never took in water on her deck; and, when at anchor, she rode more upright and even than any other ship. She also sailed very fast, either before or upon the wind, and no vessel in company, of equal size, was able, upon many trials, to beat her in sailing.

The use of sliding-keels is known, by actual experience, to be of the greatest importance. In fresh breezes, or in light winds, it is totally immaterial how much sail is set, or how it is disposed; *since the act of raising or lowering the keels will immediately counteract the inconvenience that might otherwise arise from carrying too much sail, either forward or aft.* The most trifling practice will render the navigators perfectly acquainted with their use, and the easy steerage of this ship will convince him of their advantage. In a gale of wind it is necessary that the main and fore-keels should be hauled close up, and the stern-keel let down to such depth as shall be found necessary to make the vessel steer perfectly easy.

KEFFEKIL, or *meerschaum* of the Germans. A stone of a white or yellow colour, soapy feel, and moderate hardness, which increases in the fire. The Tartars use it instead of soap. It consists of equal parts of magnesia and silex, whence it operates as a fullers-earth.

KELP, is the ashes of sea-weeds, rock-weed, or *fuci*. The species used in the manufacture of this article grow attached to rocks, between high and low water-mark. On the Scottish coast it is cut close to the rocks, during the summer season, and spread, and turned to dry. It is then stacked and sheltered, till covered with white saline efflorescence, and is then ready for burning, in a round pit or kiln, lined with brick or stone, about 2 ft. wide, 8 to 18 long, and from 2 to 3 deep. The bottom is covered with brush, upon which a little dried sea-weed is scattered, and fire is applied at one extremity; the sea-weed is now thrown on gradually, as fast as the combustion reaches the surface. After the whole is burnt, the mass gradually softens, beginning at the sides, when it should be slowly stirred up with a heated iron bar, and incorporated, till it acquires a semi-fluid consistence. This part of the process requires considerable dexterity; and, if the mass continues dry, a little common salt should be thrown on it as a flux. When cold it is broken up, and is ready for sale.

Kelp contains but 2 or 3 per cent. of carbonate of soda, while Spanish barilla often contains 20 or 30. One of the products is iodine.

The use of soda, in general, is the same with that of potash, but it is indispensable in making plate and ground glass and hard soaps, and consumed in immense quantities by soap-boilers, bleachers, and glass-makers.

It is well known that the shores of the sea, and salt-marshes, as well as the margins of interior salt-lakes and salines, and, in general, all places to which water holding salt gains access, are inhabited by peculiar plants. In these maritime plants, soda *replaces* the potash, which is always present in plants growing in ordinary situations, and if they are removed to a distance from the sea-shore, they gradually lose their soda, and acquire potash in its stead. The barilla obtained in France from the *salicornia annua* yields 14 or 15 per cent. of soda.

The Highland Society has published the following account of the manufacture of 115 tons of kelp in Harris. It was from cut-ware of two years growth, in equal parts of *lady-ware*, which grows between the spring and neap high-tides; *bell-ware*, between high and low neap-tides; *black-ware*, low water, spring and neap. It is cut with a strong reaping-hook. Sand and mud is washed off, and it is spread by day, and cocked by night. Then put into large cocks, and left to heat for six or eight days. It is burnt on a dry day, and a good breeze. The kilns are of hard stones, with turf outside, from 15 to 18 feet long, 2½ broad, and 2 feet high. Straw, or heather is laid, and set on fire, and dry ware laid on it, and added, by degrees, till the whole is in ashes. If it cakes, it must be raked. When all is burnt, it must be raked till the whole is a semi-vitrified solid. It is then broken into large lumps, made into conical heaps, and covered with dry ware and turf, till shipped.

KENTISH'S TURPENTINE LINIMENT, for recent burns and scalds, is a valuable officinal preparation of turpentine in rectified spirits; and the only safe remedy.

KERMES, (*coccus ilicis*, Linn.) is an insect found in many parts of Asia, and the south of Europe. The kermes live on a small kind of oak. The females grow big, and at length remain motionless; when they are nearly the size and shape of a pea, and of a reddish brown colour. On account of their figure, they were taken for the seeds of the tree, and called *grains of kermes*, or vermilion.

To dye worsted with kermes, it is first boiled half an hour in water with bran; then two hours, in a fresh bath, with one-fifth of Roman alum, and one-tenth of tartar, to which *sour water* is commonly added; after which, it is taken out, tied up in a linen bag, and carried to a cool place, where it is left some days. To obtain a full colour, as much kermes as equals three-fourths, or even the whole of the weight of the wool, is put into a warm bath, and the wool is put in at the first boiling. As cloth is more dense than wool, either spun, or in the fleece, it requires one-fourth less of the salts in the boiling, and of kermes in the bath. Less proportions of kermes will produce lighter and paler colours. If we want a succession of shades, we must, as usual, begin with the deepest.

A small handful of refuse wool should be thrown into the boiler, and boil a moment, before the wool to be dyed is put in. This will absorb the black dregs, and the wool dipped will take a better colour. Before the wool that is just dyed is taken to the river, it may be dipped in a bath of water a little warm, in which a small quantity of soap has been dissolved. In this way, the colour will acquire more brightness, and have a crimson cast.

By using kermes and tartar, without alum, and with as much solution of tin as is required for a scarlet with cochineal, we obtain a very lively *cinnamon colour* in a single bath.

Cloth, steeped in a solution of sulphate of potash, takes, with kermes, a pretty fine and permanent *agate gray*.

In a solution of sulphate of iron and tartar, *a fine gray*.

In a solution of tartar and sulphate of copper, an *orange;* and the same with nitrate of copper.

Solution of bismuth, added drop by drop, produce a *violet*.

All acids convert it to a *cinnamon*, which inclines more or less to red, according as the acids are weak, and their quantity small.

Alkalies render it dull and *rosy*.

Kermes imparts to wool less bloom than the scarlet made with cochineal.

KERMES' MINERAL, is the prepared substance of crude antimony, which is sold in cones of a gray colour. Dissolved in muriatic acid, with heat, it forms oxide of antimony, which, in three varieties, constitutes liver, glass, and flowers of antimony.

KETCHUP, the liquor of mushrooms, made by sprinkling them with salt, by which they are partly resolved into a brown liquor, which is boiled with spices and bottled for use.

KILLAS.—A stone; chiefly found in Cornwall; pale gray, or greenish gray; specific gravity 2·666.

KINGDOM, the mineral, vegetable, and animal, into which nature is divided. The causes of difference are, the local motions, and variety of the atoms. In minerals, there is little or no motion, and they are results of union of atoms, or crystallizations, with gazeous motions in their interstices. Vegetabies are germs, which appropriate the latent motions within minerals, and, by reactions with the atmospheric gas, generate the substance of trees and plants, the limit of the action and reaction determining the definite bulks. Animals are appropriations of the prepared substance of vegetables; and are generated by the joint action and reaction of the oxygen and nitrogen of the atmosphere. The limit of the assimilations by that action and reaction, and the simultaneous eliminations, determines the definite bulks. In the production of these kingdoms, especially the two latter, gases play so important a part, that improved knowledge demands the introduction of the genera and species of *a gaseous kingdom*; of which, with atoms of matter, vegetable and animal, all organizations are simple and regular products.

KINO, an extract of the sea-side grape, *coccoloba uvifera*, or the *resinifera*, or brown gum-tree.

Wool and cotton, boiled in a solution of kino, and then dipped in a bath of sulphate of iron, appear of a bottle-green, changed by washing and drying to a blackish-brown, very durable. Hot alcohol dissolves about three-fourths of its weight; and the remainder dissolves easily in hot water, and gives it a deep-red colour.

KIRCH-WASSER, or *Swiss Brandy*. When cherries have arrived at maturity they are pounded, without the stalks, in a large wooden vessel, their kernels not being broken. When fermentation has begun, the liquor is stirred two or three times a day; and as soon as the wash appears quiet, it is put into close barrels, to prevent acetous fermentation. The kernels are then broken and thrown into the liquor, and the whole is carefully distilled together. The best spirit is made from small black cherries.

KITCHENER'S SPIRIT OF SOUP HERBS.—For 10 days steep in a pint of alcohol ½ oz. of each of lemon, thyme, winter savory, sweet marjoram, and sweet basil, with 2 drs. of grated lemon-peel and eschallots, and 1 dr. of bruised celery-seed.

LABORATORY, the workshop of a chemist, and the seat of profit and honour to manufacturers and philosophers. A laboratory is furnished with a fixed furnace, and sundry auxiliaries and portable furnaces. It ought also to contain blow-pipes and galvanic-troughs, with crucibles, matrasses, retorts, flasks, vessels, and bottles; also a pestle and mortar, a vice, a lathe, and carpenters' tools; a pneumatic trough, a sink for water, tables, drawers, and shelves; with thermometers, a barometer, pyrometer, hydrometer, Argand's lamps, Wollaston's scale, weights and measures, &c. It requires, also, a small stock of tests and test-paper, and of sulphuric, nitric, and acetic acids; with nitre, soda, ammonia, alcohol, &c. &c.; and especially pasteboard and wire masks, and a stout apron for the stomach and abdomen. The cost varies from £200 to £500.

The expense of fitting up a laboratory to furnish articles of common consumption is very small. The instruments indispensably necessary are—An alembic, with a refrigerator and portable furnace. If the operator should not choose to go to the expense of the alembic and its apparatus, a succedaneum may be found for them in a sand-bath or sand-heat, with retorts, under suitable precautions.

*Sand-heat* is usually formed, in the large way, of an oblong shape, having bricks and mortar for its walls, plates of iron upon which to lay the sand, and around the top a ledge, of about six or eight inches deep, of free-stone, to retain the sand. Beneath the plates of iron is a wide flue, at the bottom of which is an iron grating, upon which grating is laid the fire. The fire is, of course, when kindled, enclosed by a door, as in other furnaces, at the end of the sand-heat; a flue communicates with a chimney, to carry off the smoke. The sand is commonly of the depth of six or eight inches; but the quantity and depth depend upon the size of the vessels.

A *retort* is a vessel usually made of green or other glass, and may be made to hold from a pint to eight or more gallons. It has a long narrow neck, which is so bent, that when the retort is placed, with its contents, in a sand-bath, or over a fire, it has a gentle inclination, and will conduct whatever liquid is condensed in it, into a *glass receiver*, which is placed on a bench beside the sand-heat; the receiver is luted to the neck of the retort, either by a caoutchouc skin, which is the neatest way, or by some other lute. A variety of chemical processes are thus conducted: the vapours raised by the heat being condensed in the neck of the retort, and cooled down in the receiver, (which is usually about the size of a retort,) by the large surface which it presents to the air.

On this, as on many other subjects, more is learnt in half an hour, by actual inspection, than by half a volume of description.

LABOURERS' GARDENS.—On this most important subject Mr. THOMAS POYNTER, a working gardener of Fulham, has published a very valuable tract at a low price. It will teach the wealthy, as well as the labourer, and we must refer to it for further details. It has appeared after the articles on COTTAGE GARDENS and HORTICULTURE were printed. A comfortable cottage should have four rooms, consisting of a kitchen, sitting-room, and two bedrooms; a wash-house, cellar, and pantry. It should front the mid-day sun, and, to the west, should have a cow-house and pig-sties; and to the east, a tool and barrow-shed. For extent of garden, Alfred's allowance was a rood, or 40 square poles, or 1210 square yards, of land, nearly facing the south or south-west, and a gentle slope, and sheltered from the north, and particularly from the north-east.

The best garden-lands seem to be on the banks of rivers, of a rich, black, and soft texture, and always free-working. Very stiff clay and harsh gravels are the worst. The materials necessary for the raising of crops may be classed under the following heads:—Manure, tillage, digging, hoeing, sowing, transplanting.

Manure of some sort the cottager

must obtain. If he keeps a cow or a pig they will assist. The refuse of the garden will be an equivalent, where good digging and hoeing are done. The chief purpose of manure is to break the soil. A useless spot should be chosen as a depository for the rakings, sweepings, and clearings of the garden, with the ashes, soap-suds, sweepings, and offal; and a few barrowsful of the droppings of horses and other animals, and drift from the roads. These heaps should be well turned and fermented, always ready for use. On clayey soils, ashes, lime, or chalk, are useful. Leaves, put in a heap, with a few spadesful of mould thrown over them, ferment, and give more lasting heat than stable dung.

Tull clearly proves, that when the ground is in a state of pulverization, it absorbs more moisture, and is more readily acted upon by the sun and air, and better adapted to give to the plant the nourishment requisite for its support; hence the soil must not only be finely but frequently broken, and that this is effected by growing plants in rows and working the soil between the rows, sufficiently deep during their growth. Every stirring of the soil, when it is not in a wet state, creates a new fermentation of the particles of which it is composed, and furnishes fresh nourishment to the plants.

Mr. Poynter believes that the beneficial effects of liquid manure arise chiefly from the destruction of grubs, insects, &c. Cow urine is immediate destruction to slugs and wire-worms; it will destroy grubs and moss upon trees, and give a luxuriance both to trees and young crops, but it must be administered to trees during a frost, to young crops during the spring, and must be poured near them but not upon them; seeds may be soaked in it for a few hours. Poured round the roots of gooseberry-bushes, the soil having been first a little stirred, it will defend them from caterpillars.

There is (says Poynter,) a large south border at Walham Green, in the parish of Fulham, that I have known to be every year sown with radishes (a more exhausting crop than peas,) for above forty years, with the exception of two years, and, to judge from the crop that is on it, at the very time I am writing this, the land is not tired of them yet, and, I think, never will be. What a deal of proper food for radishes must be contained in the soil of this spot! Rotation of crops is, however, advisable, on account of working the land deeper and oftener than many crops will admit, if they are continued on the same land. Cabbages, lettuces, and many other plants of annual cultivation, may be grown on the same land for ever. Of mint, rhubarb, and strawberries, I recommend the frequent removal, but they are perennial or lasting-rooted things, and the roots get matted together, and there is no way of coming at the soil, to work it and give fresh nourishment, but by transplanting all such.

I will suppose the cottager to be put into possession of his half-acre at Michaelmas, which is the most proper time for the cottager to begin. If the next farmer would run his scuffler (which ought to be one with curved bar teeth) through it twice, it would root up all the stubble and weeds, and cause them to shed their seeds; and the cottager must then rake up and burn. In a fortnight, one more scuffling, in dry weather, will destroy them entirely; but, if this last scuffling cannot be done, the weeds will remain in the soil, and like autumn-sown wheat, will start in the spring. A plough should then throw up the piece into high ridges.

For clays, and for any kind of pasty tenacious soil, which sets after every shower of rain, the greatest of all improvements is burning. This produces a degree of lasting fertility in the soil which no manure can equal; every weed and every root of every weed are destroyed. The burning should be done in long ridges of five or six feet high, and about eight or nine in width; if wood cannot be had, tussocks of coarse grass may serve the purpose. The less vent with which the fire can be worked, and the slower it is worked the better, the ashes should be ready to moulder when they come out, and the greatest proportion of them should be red. The exuberant fertility which soil, burnt to the depth of eighteen inches or two feet, will produce in a garden is immense; and the greater facility with which land may be worked thereafter, will admit the use of the light shovel, instead of the strong and heavy spade.

Land can never be dug too well. The spits should be thin and finely broken. Trenching may very often be done to advantage. It is superior, in its effects, to digging. It is also the best way of burying a heavy coat of manure. It should be remembered that, if the land is trenched above one spade's depth, the bottom, or under spit, should never be cast to the top, for the naturally-upper soil will always be the best. It is a good way to dig or trench land into rough spits or ridges, that the action of the sun, the air, the frosts, and the rains, may break the adhesive lumps of the soil. In the dry and burning heats of summer, as well as the severe frosts of winter, it is equally beneficial.

Hoeing, as well as digging, should, in general, be done deeply; and, if possible, when the weather is dry. Hoeing is not to be done merely to kill weeds, but also to move the soil, and give nourishment and strength to the crops during their growth. It is a common but erroneous notion, that frequent hoeing is injurious to crops in dry weather. Its effects are directly the contrary; it creates moisture. A cottager should have a seven-inch hoe, besides some smaller ones of four, three, and two inches.

Every tool, when not in use, should be carefully cleaned and put by. Nothing is more slovenly and unsightly than to see, in a garden, tools scattered about and eaten up with rust.

The principal art in transplanting is, to close the roots of the plants tightly without bruising or injuring of them. If the plant will stand a gentle pull without coming up, it is properly closed.

Many articles are propagated by slips, cuttings, suckers, &c.; by slips, many herbs, such as sage, rue, horehound, &c.; many others by cuttings, even in the fruit department, such as gooseberries and currants; others by suckers, as raspberries; others by runners, as strawberries; others by parting of the roots, as tarragon, thyme, rhubarb, potatoes, &c.

A layer is a branch of a tree, shrub, or flower-plant, which is bent down and fixed in the earth, where, if properly managed, it takes root: and, when it is rooted, is removed from its parent tree, shrub, or flower-plant. The branch is generally twisted between that part that is laid in the earth, and the tree it is laid from.

Budding and grafting are operations simple enough, but it is knowledge that comes by the eyes, and may be learnt from a good grafter and budder in five minutes.

Seeds may be saved by the cottager, but he must not attempt to save every sort. Onion, leek, lettuce, and radish seed, may be saved; but of the cabbage tribe never save but one sort; and take care it does not stand too near a neighbour's garden who is saving another sort. Give away freely, and beg freely.

In gardening, it is important not to suffer a weed to live. There are perennial or lasting-rooted weeds, whose roots last for years: such as docks, nettles, couch, thistles, bearbind, dandelion, and others, whose roots must be forked up. Other weeds are annual, as the sow-thistle, groundsel, chickweed, shepherd's-pouch, and many others, easily destroyed in their infant state.

Beans may be planted in rows of about two and a-half feet apart, and about six inches from bean to bean. If you have any peas or beans up, sown in November, they should be carefully earthed up a little on a dry day. In severe weather, if the beans that are up can be protected by some covering that will not press upon them, it will forward and save them, as the quantity in a cottager's garden must generally be small, they may be protected by thin boards, nailed together like an inverted water-spout, or a hog-trough turned topsy-turvey, removing the board in the day-time, unless in very cutting frost. The boards or frames would be of use, afterwards, in protecting many sorts of things from spring frosts, as French beans, and so on.

White and green cos-lettuces should be sown in January, on a warm open spot, where the land is light and rich. The seeds should be lightly raked in, in fresh-dug ground. The weather, however severe, will seldom injure them. A little hot-bed, hooped over, by bending some hazel or willow rods, and covered with mats or canvass, it will be a certain way of procuring plants fit to transplant about the beginning of April.

Radishes may be sown, if the ground is dry, for early use, in January. The salmon-coloured is the best. To sow radishes properly, mark out a bed, not exceeding four feet wide, by a drill on each side, three inches deep. Rake the bed level, sow the seeds, and then cast up the mould from the outsides of the drills, covering the seeds about half an inch deep; rake the cast-up mould lightly over; and then cover it with straw, litter, and fern leaves.

Carrots or parsley may be sown with the radishes, but the radishes must not be sown thick, or they will destroy the carrots.

A cottager will find an advantage in sowing most of his seed-beds in drills, from their being more easily cleaned from weeds; and also admitting of deep hoeing between the plants, which will feed and strengthen them.

Many small-seeded plants may now be forwarded much, and with more certainty, than if sown in the natural ground, by sowing a garden-pot or two, according to the quantity desired, and placing them in the window on the sunny side. A pot, sown with leek-seed, will contain a hundred or two of plants, which may, in a subsequent period, be turned out of the pot, and with the mould which was in the pot, plunged in the open ground, or the plants pricked out to strengthen, till you want to transplant them. The same may be said of celery, lettuces, and many other things. They should not, however, be suffered to draw up long and spindling, and when they begin to draw place them in the open air. Neither should they be watered too much. It is generally the fault to kill their geraniums, and other potted plants, by saturating them with too much water.

In a cottage-garden a pit may be dug, about two or three feet in depth and four in width, and a strong bed of leaves be put in, in the autumn, and soon after Christmas, the leaves be well turned, and about five or six inches of mould thrown over them. In this gentle hot bed, coarsely covered, many seed-plants, of both vegetables and flowers, may be forwarded.

Of mustard, cress, rape, and radish, there may be a constant supply by sowing in-doors, in pots or pans about three inches deep. Sow the seeds thick, and sift or shake over them a slight covering of fine mould, and it is best to water the mould in the pan before you sow the seed.

A patch of horse-radish, in any out-of-the-way corner, is mostly propagated by planting the crowns deeply in the ground; and it may be planted any time from October to April.

The land for carrots should be of a light sandy nature, not too poor, and not freshly manured; for if it is, it will canker them and make them scabby. It ought to be well and loosely worked. The seeds are light hairy-winged things, resembling as many dried dead wood-lice: they adhere very much to each other. Before you sow them rub them well apart, with a handful of dry ashes, pounded whiting, or scraped chalk, or sand, to separate them. The seeds, when sown, should be well raked in, and then the ground trodden over, or rolled, if dry enough.

March is the general month for sowing onions. On light lands as early as possible in the month. On cold lands towards its close. The land should be worked down very fine. The seeds should be sown regularly and evenly, and then lightly raked in. Afterwards the ground should be closely trodden. Cottagers would succeed best by drilling them in. A driller is made by punching out every other tooth from a stout rake. The drills should be half an inch in depth, and sow the seed in the drills, and cover them with your feet, or with the head of the rake. Rake it smoothly, then tread all over. Onions, in their various sowings and uses, are one of the principal crops of the garden. The best sorts to sow for general use, are the Reading or Sandy's onion, the Deptford, and the James's or Globe.

A small patch, or bed of onions, should be sown very thickly on poorish ground, early in May, to make bulbs to plant out in November, or in the spring, to produce large early-headed onions next year. The Reading onion is the best to sow for this purpose.

Onions sown in August are called Michaelmas onions. They are sown thickly in beds, to stand the winter, to use small and green in the spring, for salads with radishes and lettuces. Sow about an ounce of seed to every four square yards, on beds of about four feet wide, nicely worked and raked. The best sorts are the Lisbon, Reading, and Deptford onions. The Welsh onion has only the merit of being more hardy.

In the Spring hoe well and deeply all Autumn-planted crops. Clear away the litter from the early radishes. Earth up peas and beans as they advance. And get all hardy articles planted and sown.

If a cottager has a few rods of ground to spare, and has a cow or pigs, he should sow a patch of mangel wurzel. It may be sown in drills, and afterwards transplanted at about 12 inches in the rows, and 18 inches from row to row. Red-beet would be still more profitable to grow for cattle than mangel wurzel. It is much sweeter and more nutricious, but it requires three or four hours boiling.

French beans may be sown about the middle of April. They should be sown in drills about two feet apart; the seed to be dropped in the drills at the distance of three or four inches, and then covered with the mould from the drills about two inches in depth. The dun-coloured, the black negro, and the white Canterbury are the best. Scarlet runners, called "the poor man's bean." They should be sown before May, and in a similar manner to French beans, but not so thick, and a little deeper. If carefully transplanted they do very well.

April is a good time for parting and planting out the roots of herbs; as thyme, hyssop, lavender, wormwood, horehound, balm, or winter savoury.

There are some herbs which will not propagate by seed, or of which the seed is with difficulty obtained, such as sage, mint, and some others; for where plants can be raised from seed, they are always the best. The seeds being very small, should be but lightly covered. Sweet bazil and sweet marjoram are obtained from seeds imported from Italy. A pot of each, placed in a sunny window, will supply half a dozen cottage-gardens. April is the best time for raising sage-plants from slips.

In May, beans that are in full blossom should be topped, by pinching off the top of the bean-plant beyond where it is in flower.

Brocoli should be sown early in May, late and early, white and purple, sprouting and Cape. It is difficult to procure good brocoli-seeds, as it mixes with every flower of the cabbage tribe; and every sort must be saved at a great distance from each other.

If you have any plants of brocoli, cabbages, savoys, green-cole, Brussels-sprouts, leeks, or others, plant them in May, at about two feet from row to row; but leeks one foot from row to row, and about six inches in the rows.

Girkins, or pickling cucumbers, may be sown in the beginning of June. Draw a drill about two inches deep, drop the seeds about three or four inches apart, cover the seed, and, if the ground is dry, tread it lightly over. They must be thinned out to a foot apart; but they must have a rich and open spot, and not be shaded by other crops or by trees. The London gardeners sow a short hardy sort, differing much from those sown for frame produce.

Endive is a wholesome and pleasant salad. Sow it about Midsummer. The smooth-leaved is commonly called the Batavia indive; but the curled is mostly preferred. The method is similar to that of lettuces. It grows on the ground as flat as a pancake; but the leaves must be gathered up, and tied tightly, when the weather is dry. In a fortnight or three weeks after tying it will be fit for use.

The fly is a dreadful enemy to the whole of the brassica or cabbage tribe, in their seed-leaved state; but more particularly destructive to the turnip. The best remedy is throwing over the plants slacked lime, soot, ashes, or dry-dust, early in the morning, while the dew is on the plants; and the next best thing is to take a handful of elder-boughs, well-leaved, and brush over the young plants with them.

The white round, the mouse-tailed, and the six weeks' turnips, are the sorts to be preferred for garden crops. The middle of July is the best time to sow a principal crop for autumn, winter, and spring. They will be fit to pull by Michaelmas, get better to Christmas, and continue good till spring. Sow them thin, and rake the seeds lightly in, and, if dry weather, tread the ground firmly over. As soon as they show a single rough leaf, hoe them out to four or six inches apart; on the second hoeing, which must follow soon after the first, thin them out to nine inches or a foot apart.

July is the time for sowing cabbage-seed for planting. From the sowing at this time, cabbages may be planted out at least nine months of the year. It has been a practice, among the market-gardeners of Fulham, perhaps for many generations, to sow their cabbages on the 25th of July. It is not superstition. It is not a whim. It is the result of experience, traditionally delivered in this parish by careful and observant growers. From the time of sowing it takes two years to perfect its seeds. To have it good, it must be obtained from cabbage stumps, which have cabbaged the previous summer. When the plants are up, they should be thinned out by a small hoe as early as possible, to about two inches apart, if sown broad-cast. If sown in drills about an inch distance will do in the drills. Be careful to tread the ground over after the seed is raked in.

Spanish radishes are large turnip-rooted black radishes. In July, sow three or four drills about six inches apart. When well up, thin them out to that distance in the rows. They are in use all the winter, being very hardy.

In the middle of August, sow a principal crop of spinach. It will be in use from Michaelmas to the end of May. It must be well manured, and may be sown broad-cast, or in drills about five or six inches apart; or, when the plants are up, they must be hoed out to that distance. Flanders spinach is the best.

Rhubarb is an article that ought to be in every cottage garden. Its produce is great and certain, and a dozen large roots will produce a constant succession for pies and puddings from April to September. It may be raised from seed, but the most expeditious way of bringing it to maturity, is, by parting the old roots; and putting them out in November, at about 18 inches apart in the rows, with plenty of rotten dung into the trench with them. The leaf-stalks should be but sparingly gathered the first year, afterwards they will produce plentifully for six or seven years, when they should be parted again. If raised from seed, the seeds should be sown in August or March, and the plants kept clean from weeds, till the autumn following the summer after they have been sowed. You may then plant them out in a nursery-bed at about six inches apart, where they must be another year; after which, they may be planted out where they are to remain, about 18 inches apart. If more rows than one, let the rows be at least four feet apart.

Blanching converts an extremely bitter vegetable into a sweet one. Cabbages, lettuces, endive, and celery, by earthing, is blanched, and would be worthless without it.

Apple-trees and pear-trees may find their way into every cottage-garden; in planting which, the ground should be well and deeply worked, the earth well closed about their roots, and not be planted too deep. The autumn months are the best. The Hawthorn Dean and the Keswick codlin are the most valuable kitchen apples, as they are prodigious bearers, and come quickly.

Of cherries, the Morella is the most useful and the greatest bearer. Of plums, the early Orleans, and the yellow egg, take the lead, in point of bearing and utility.

Gooseberries must have a place in every cottage-garden. The Lancashire weavers have raised from seed better sorts than regular gardeners. They are raised from suckers, or cuttings of the last year's wood; which should be planted out in rows, about a foot apart and six inches in the rows, during the winter. In two years they will be fit to plant out finally, at four feet distance in the rows. They must be carefully pruned every winter, cutting nearly all the young wood out, leaving only the leading shoots, and such as may be necessary to form branches. During the time they are in blossom, they must be carefully guarded against birds. But the best gooseberry for all purposes is the little rough red.

Red and white currants are two of our most valuable English fruits. Their uses for puddings, pies, jellies, jams, or wine, is equalled by no other fruit. The red should be the principal fruit of the cottage-garden. It is propagated in a similar manner to gooseberries. The pruning is nearly the same, except that the leading shoots of the currants should every year be shortened to about five or six inches in length, which the gooseberries should not. Black currants will not bear much pruning, and the shoots should not be shortened.

A few stools of raspberries should be in every garden. There are but three varieties. The small common red, the large red Antwerp, and the white, or yellow. The first is most preferred for confectionary uses, and the other two are mostly grown for table use. The only mode of propagation is by suckers, of which every old stool sends forth plants every year. These should be planted about two feet apart, in any of the winter months; shortening them down the first year to about a foot in length. The first year they will bear but little; but, if carefully managed, will send up a supply of canes for next year. These, the next winter, should be thinned out, to six canes to a stool, and, after topping the canes a little, be tied to a stake, cutting the old wood or canes off close to the ground.

If such gardens were universal, the materials of gaols and work-houses might be converted into cottages, since the employment would leave neither leisure nor motive for crime, and the produce would keep misery and poverty at a distance.

LACE BARK-TREE, *(legetta lintera-ria.)* of Jamaica, affords, in its inner bark, laminæ like gauze, and, in many respects, like bobbin-net; durable, but requiring some preparation.

LACQUER. *(For metals and wood—a golden colour.)*—In 5 half-pints of alcohol dissolve 1 oz. of seed-lac, gum dragon, gamboge, and annotto, also 2 drs. of saffron.—*Or*, In 12 oz. of alcohol dissolve 1 ℔. of turmeric, 2 oz. of annotto, and 2 oz. of shell-lac and juniper gum.—*Or*, In 2 pints and 4 oz. of alcohol dissolve ½ dr. of saffron and of extract of red sanders, 1 dr. of gum dragon, 2 oz. of amber and of gamboge, and 3 oz. of seed-lac.—*Or*, In 1 pint 4 oz. of alcohol, dissolve 6 drs. of turmeric and 15 grs. of saffron; decant, and add 6 drs. of gamboge, 2 oz. of gum elemi and of gum sandarac, and 1 oz. of gum dragon and of seed-lac.

*Lacquer for Tin.*—Take 8 oz. of amber, 2 oz. of gum lac, melt them in separate vessels, and mix them well together; then add ½ ℔. of drying linseed-oil. Into a pint phial put half a pint of spirits of turpentine, and digest in it a little saffron; when the colour is extracted, strain the liquor, and add gum tragacanth and annotto, finely powdered, and in small quantities at a time, till the required tone of colour is produced; then mix this colouring matter with the first compound before prescribed, and shake them well together till a perfect union takes place. If this varnish be laid over silver-leaf or tin-foil, it will be difficult to distinguish it by the eye from gold. It is by a varnish of this kind that leather, paper, or wood, covered with silver-leaf, is made to appear as if it were gilded. The lacquer is also applicable to tin-plate articles, but small articles of finely-polished brass are usually coated with a thinner composition.

*Lacquer for Brass or Silver.*—Take 2 oz. of seed-lac, 2 oz. yellow amber, 40 grs. dragon's blood, 30 grs. saffron, 40 oz. spirits of wine, and digest on a sand-bath. Strain through a fine cloth, and cork. Clean and burnish the buttons, heat them, and apply the lacquer.

*Lac Spirit*, is made of muriatic acid (sp. gr. 1·19) 60 lbs., tin 3 ℔s. dissolved. It is used in dyeing with lac dye.—*Or*, It may be made of aquafortis 28 ℔s. and tin 4 ℔s.; dissolved gradually and stirring frequently.

LACTIC ACID, is formed by sour milk and by starch and water.

LAKE, is best made by enclosing 2 oz. of fine madder in a large calico-bag; pour on it, in a mortar, a pint of pure water, and press and pound it. Pour it off, and repeat with other water four or five times. Heat to 180° and pour it into a pint of boiling water, containing an oz. of alum, or for deep colour less. Stir, and add a solution 1½ oz. of subcar. of potash. Decant the yellow liquor, and add to the precipitate a quart of boiling water. Cool and filter for half an oz. of lake. Other vegetable colours also produce lakes.

LAMPS, were ancient contrivances for oxydating oil and generating the vibrations of light. The method was, to insert a fibrous absorbent wick in the oil, light the wick, and then the vacuum, generated by the flame, kept up the absorption and ascent of the oil till it was converted into gas and aqueous vapour, and the wick and oil into smoke. The local excitement of the atoms generated the waves called light. As the ancients enquired little into cause and effect, so no improvement distinguished lamps, till Argand, in 1780, by a transparent chimney, produced such a current of air and oxygen, as conferred new powers on lamps; while, since then, Winsor introduced his ready-made gas, and changed our economy and practices in the generation of light. Among an infinite variety of forms and improvements—

*A Platina Lamp* has been made by Mr. Merryweather, of Whitby.—If a coil of small platina wire be placed around the wick of a spirit-lamp, and rendered red-hot, the wire continues ignited for some time after the flame is blown out. The lower part is constructed of tin, in the body of which is a reservoir, large enough to contain a quart of alcohol. The bottom of the interior of the reservoir is concave, in order that the cotton wick may take up the last drop of the spirit. After the wick has been spread in the form of a coronet at the top of the lamp, a platina-wire cage, containing *one* piece of spongy platina, is to be pricked into the centre of the wick, and to be kept nearly in contact, but not to touch it. After the reservoir has been filled with alcohol, the wick is to be inflamed, and a minute afterwards the spongy platina becomes incandescent, when the flame of the wick is to be suddenly blown out, and the glass cover to be immediately placed over the platina. Without any further care or attention, the platina ball will keep ignited for 13 or 14 days and nights. If a tube is connected with a reservoir (containing a sufficient quantity of alcohol) and the bottom of the reservoir of the lamp, the platina ball may be kept ignited for years, as the spongy platina does not appear to be in the least deteriorated by being kept in a state of constant ignition. Two objections to this lamp, the expence of the alcohol and the odour, are removed, since equal parts of alcohol and whisky answer as well as pure alcohol; or one-third of alcohol and two-thirds of whisky, which cost one penny for eight hours. As a remedy for the second objection, an apparatus for condensing the vapour is made of tin, which is to be suspended from a nail in the wall. The glass tube of the lamp is to be inserted into the tin tube of the condensing apparatus, which will completely destroy the strong odour, of the vapour, and the liquid is drawn off by the stop-cock at the side of the condenser.

*Spirit-Lamps* are those used with cotton wicks and alcohol, and though the flame is slight the heat is intense, and its action on metals, &c. effective. As the alcohol approximates pure hydrogen, and has little carbon, it fixes much oxygen, which confers the heat, and there being no carbon, there is little light and no smoke; so that it forms no carbonic acid, and the gases are concentrated into aqueous vapour, giving out great heat for all chemical purposes. The heat is greatest just within the summit. Sometimes four burners are used, and one and two chimneys above each other, to place over the whole, allowing air to enter at the bottom, and in this case the highest degrees of heat are attained at an easy expence. The spirits or alcohol should have 0·85 sp. gr., *i. e.* six pints should weigh five pints of water.

Spirit-lamps produce little flame but intense heat, since white light and flame result from the joint action of hydrogen and carbon. They are to be trimmed with a twisted cotton wick and alcohol, and they have the advantage of intense heat, without smoke or chemical combination with substances applied to them.

Sometimes several wicks are combined in a hollow cylinder, raised above the table, and a chimney may be added, with which it becomes a powerful furnace. The alcohol should be about ·84 or ·85. Pyroligneous ether may be substituted for alcohol, as cheaper.

Double, with Argand oil-lamps with separate rack-work, are very powerful and luminous, with free access of air.

To prevent the breaking of lamp-glasses by sudden heat, cut or scratch the base of the glass with a diamond, and afterwards sudden heat may be applied without danger.

LARCH, a valuable tree, which flourishes in Britain, in elevations of 1200 feet above the sea. Its timber is valuable, and it grows rapidly, being in perfection in 30 or 40 years. When cut down and peeled, it should be kept six weeks in water, to prevent splitting, and then hollow-laid in the shade. Its bark is valuable for tanning, and its wood is adapted for every purpose except doors and window-shutters, in which it warps. The droppings of its leaves promote the growth of grass, and it has no diseases, unless planted too close. The best seed is from Carniola or alpine districts. A single tree has been sold at 12 guineas.

LATHE, a valuable and amusing machine, used for turning either wood, ivory, or metal. Its tools are gouges, drills, chissels, screw-tails, &c. The common forms are to be had everywhere, but great and efficient improvements have been made by Maudsley, Smart, Holzapffel, &c. No country-seat is provided with objects of amusement without a lathe, and every experimentalist finds one of daily use.

To inspect work in the turner's lathe, without stopping it, shift, by means of a lever, the band from the pulley, which is fixed on the mandril, to one that is loose on it, by which the tread-wheel and band continue their motion while the work is examined.

Wood may be ornamented in the lathe by a composition of shell-lac and resin, mixed with red-lead, Prussian blue, yellow ochre, &c. A ball may be applied, while turning, and polished by a piece of cork.

Mr. Tyler, of Philadelphia, has directed attention to the fact, that cast-iron is superior, as a collar, to the hard steel mandrel usually applied to a lathe. It also diminishes the labour of making it, and affords a solid, in place of an inserted, collar; besides which, the lathe is found, by experience, to run a much longer time without requiring to be fresh oiled, than when steel.

LAVENDER WATER. — Take of English oil of lavender flowers 3 drs., oil of angelica root 6 drops, rectified spirit of wine 1 pint. After being shaken in a quart bottle, add 1 oz. of fresh orange-flower water, 1 oz. of fresh rose-water, and 4 oz. of distilled water. To this composition, those who like the musky odour may add 2 or 3 drs. of the essence of ambergris, or of the essence of musk.

*Double-distilled Lavender Water.*— Steep 2 lbs. of picked flowers in 6 pints of alcohol 3 days; and then distil off.—*Or*, 2 lbs. of flowers to 8 pints of alcohol.—*Or*, 5 oz. of oil of lavender, and 2 drs. of essence of ambergris to 1 gall. of alcohol.

LAVENDER DROPS. — Infuse in 3 pints of spirit of lavender and 1 pint of spirit of rosemary, ½ oz. of nutmeg and of cinnamon, and 3 drs. of red sanders wood.

LAUDANUM.—In a pint of mountain wine digest three days 2 oz. of opium, 1 oz. of crocus (peroxide of iron,) with 1 dr. each of aloes, mace, cloves, and cinnamon.

LAURUS, a genus of plants, whose species yield important and valuable products. One is the cinnamon, another the cassia, a third the camphor, a fourth the sassafras, a fifth the sweet bay-tree.

1. *See* CINNAMON.

2. The *Cassia* is an Oriental tree, which yields buds equal to cinnamon-bark, for all its purposes, and also an inferior kind of bark.

3. *See* CAMPHOR.

4. *Sassafras* is an American cinnamon and a native of Florida. It is variously employed in medicine, and alcohol forms a tincture of its properties. It is often taken as tea, with opinions in its favour.

5. *The Sweet-bay* yields leaves, berries, and a fixed oil also, employed in the relief of several diseases.

LAWNS.—In the metropolis and its neighbourhood, the turf laid down in small gardens seldom lasts more than one season; and requires to be renewed at an expense, including the purchase of the turf and laying it down, of from 3*d.* to 4*d.* a square foot. Instead of being at this expense, if the ground to be turfed were to be stirred up to the depth of three inches or four inches every spring, in the last week of March or the first week of April, and thickly sown with the following seeds, it would soon become green; and if regularly sown, will remain as close and thick as any turf whatever during the whole summer; dying, however, in the succeeding winter, and requiring to be renewed in the spring. The grasses for this purpose are:—Agrostis vulgaris var. tenuifolia, festuca duriuscula, festuca ovina, cynosorus cristatus, poa pratensis, avena flavescens, and trifolium minus. These seeds are to be mixed together in equal portions, and sown at the rate of from four to six bushels per acre. In lawns and shrubberies in the country the turf frequently fails under large trees, and in various other places; and there is no cheaper or better mode of making good these defects than by sowing the above mixture early every spring.—*Gard. Mag.*

LEAD, is a metal very anciently known. Its alchemical name was *Saturnus.* It is found as galena, or a sulphuret, 1 lead and 1 sulphur, sp. gr. 7·568; but, being roasted, the metal is 11·35. Being often combined with silver, it is then burnt in an air-furnace, and the flakes of oxide are *litharge*, which the silver sinks to the bottom. The protoxide, or litharge, 13 lead to 1 atom oxygen, is yellow. The sesqui-oxide, or massicot, 13 to 1¼, is red-lead; and the peroxide, 13 to 2, is brown. Massicot is made from the scum of melted lead, and this scum melted in a hot furnace with flames.

It is but slowly affected by the atmosphere at common temperatures; but, when maintained in a state of fusion, it absorbs oxygen rapidly, and is converted into a dull-gray dross or powder.

When this dross is heated to a low ignition, it becomes of a dull-yellow colour, and is called *common massicot;* and, by a higher heat and longer exposure to the air, it assumes a deeper yellow, and is then called *massicot*. This is the *protoxide of lead*, and consists, in 112 parts, of 104 lead and 8 oxygen. When it contains about four per cent. of carbonic acid, it is called *litharge*. It unites with acids, and is the base of all the salts of lead. If the protoxide, or metallic lead, be subjected, during 48 hours, to the heat of a reverberatory furnace, it passes to the condition of red oxide, or what is commonly called *minium*, or *red lead*. Its composition is, in 116 parts, 104 lead, 12 oxygen.

Lead forms a compound with chlorine, 104 to 36. The union is effected by adding muriatic acid, or a solution of common salt, to the acetate or nitrate of lead dissolved in water. This *chloride* fuses at a temperature below redness, and forms, as it cools, a semi-transparent horny mass, sometimes called *horn lead*.

The pigment called *mineral*, or *patent yellow*, is a compound of the chloride and protoxide of lead. It is prepared for the purposes of the arts by the action of moistened sea-salt on litharge, by which means a portion of the protoxide is converted into chloride.

*White* LEAD, or carbonate of lead, is prepared by exposing narrow slips, or thin lead, to the steam of vinegar, in a close vessel. The slips are laid on bars of wire above the surface of the boiling vinegar. For flake white, dilute sulphuric acid is preferred.

There is, (says Thomson,) only one direct poison among the salts of lead, which is the carbonate; and, when the other salts of lead display poisonous effects, these are to be attributed either wholly, or in part, to their conversion into the carbonate. This salt acts as a powerful sedative astringent on the living system, diminishing the nervous energy, and, consequently, greatly depressing the powers of the circulation, and lowering the tone of the muscular system. It is probably taken into the blood, which may account for its slow operation when it is introduced into the stomach in minute doses, for a considerable length of time, and also for its producing similar effects, when applied to the surface of the body denuded of the cuticle, or in a state of ulceration.

Great mischief has been produced by the use of lead in dairies. If the milk runs into the slightest acidity, some lead will be dissolved, and injurious consequences will follow if it is taken into the stomach.

*Lead in Wines* is detected by a black precipitate, which will be instantly produced by the following mixture. Expose equal parts of sulphur and powdered oyster-shells to a white heat for a quarter of an hour. When cold, add an equal quantity of cream of tartar, and boil them with water, in a strong bottle for an hour. Transfer to ounce phials, and add to each 20 drops of muriatic acid.

*To reduce Red Lead.*—Heat in a Hessian crucible 2 oz. of red-lead with 2 drs. of powdered charcoal, and 1 oz. of common salt. The result will be 2 oz. of pure metal.

When nitrate of lead or of bismuth is boiled with carbonate of lime, magnesia, or barytes, these salts are decomposed, and the oxides are so completely precipitated that hydrosulphuret of ammonia shows no traces of them in the solution. Carbonate of lime, when added to a cold solution of these metals, precipitates only the oxide of bismuth. Several methods have been proposed for separating the lead which is contained in the bismuth of commerce; but carbonate of lime is preferable.

Leaf and sheet lead is most convenient in the chemical laboratory.

*The* LEAD, is an instrument for discovering the depth of water. It is composed of a large piece of lead, from 7 to 11 lbs. in weight, and is attached, by means of a strap, to a long line, called the *lead-line*, which is marked at certain distances, to ascertain the fathoms.

LEAVES, are the part of the vegetable world in which vegetable life manifests itself most strongly. Light and air act chiefly on the leaves; and, in relation to the air, leaves have been compared to the animal organs of respiration as lungs placed externally. They are also organs of nutrition, particularly on the lower surface. The same formation which prevails in the trunk, branches, and roots, has been recognised in leaves, only that what in the former is annular and concentric, in the latter is spread out over an extended plane surface. The spiral vessels and sap-vessels, which are observable in the leaf-stalk, are also partly to be traced in the leaf, and form the nerves and veins, which may be considered as the skeleton of the leaf. The spaces between them are filled with a cellular substance, covered by a soft, yet firm cuticle. The cellular substance and the cuticle are different on the upper and the lower surfaces; and, however various the form of the leaves, much conformity always exists in this respect, and is intimately connected with the life of the plant. The cellular substance is particularly filled with sap, generally of a green colour. The cells of the upper surface are commonly disposed lengthwise; those of the lower surface, breadthwise; both commonly destitute of sap. The pores, which are generally only on the lower surface (except in plants whose leaves lie on the water, or close on the ground), serve to transmit the air to the internal parts of the plant; but in some plants they are not discernible, even in some of the more perfect kinds, particularly if the sap is not green. The leaf changes whatever passes through it into the plant from without, or from the plant.

Leaves of vegetables are expansions of bark, traversed by veins. The veins consist of spiral vessels, enclosed in woody fibre, and they originate in the medullary sheath and liber.

Leaves elaborate the sap which they absorb from the alburnum, converting it into the secretions peculiar to the species. All the secretions of plants are formed in the leaves, or, at least, the greater part; hence, secretions cannot take place if leaves are destroyed; and the quantity of secretion is in direct proportion to the quantity of leaves, and to their free exposure to light and air.

Leaves gathered early in autumn, dried, and then put in wooden casks, and covered in pits, are used as fodder for cattle in many countries. Those of the elm, poplar, oak, and ash, are preferred.

LEAF-BUDS, in vegetables, develope themselves in three directions; horizontal, upward, and downward. They resemble seeds; from which they only differ in propagating the individual, while seeds propagate the species. In some plants, a bud grows and forms a new plant, if placed in circumstances favourable to the preservation of its vital powers. But, not separated from the plant, the matter they send downwards becomes wood and liber, and the stems they send upwards become branches. If there are no leaf-buds, there will be no addition of wood: and, consequently, the destruction or absence of leaf-buds is accompanied by the absence of wood; as is proved by a shoot, the upper buds of which are destroyed, and the lower allowed to develope, for the lower part increases in diameter, while the upper remains of its original dimensions. The quantity of wood, therefore, depends upon the quantity of leaf-buds that are developed.

If a cutting with a leaf-bud on it be placed in suitable circumstances, it will grow, and become a new plant. And if the cutting is applied to the dissevered end of another plant, called *a stock;* the roots are insinuated into the tissue of the stock, and the plant is then said to *be grafted*, and the cutting called a *scion*. A leaf-bud, therefore, when separated from the stem, becomes a new individual, whether it is planted in earth, into which it roots, as an eye, or in a new individual, to which it adheres and grows like a scion as *a bud*. Every leaf-bud has, therefore, its own distinct system of life and of growth. A plant may be considered as a collection of a great number of distinct identical systems of life, and, consequently, a compound being.

LEATHER, is gilt by brushing it with whites of eggs, laying on gold or silver leaf, and then burnishing with a tooth, or a knob of ivory.

To make leather lustrous, wash it with a mixture of whites of eggs, gum-water, and powder of antimony, or black-lead, and burnish.

*Morocco Leather*.—The *statice coriaria* is used for tanning goat's-skin, to form what is called *Morocco leather*.

*Russia Leather*.—The *tar* extracted from the bark of the *betula alba*, or common birch, by the common process, is what gives the peculiar smell to *Russian Leather*; the mode of application is kept secret: neat or calf leather is employed.

LEECHES, are oviparous, and the strings of their eggs, floating on water, are hatched by the sun. They come to the surface of ponds before a thunder-storm, or by agitation, and then are caught. They live best in wooden vessels, half filled with rain water, and covered with paper, with holes pricked in it. The water should be drawn off with a cock, or syphon, and fresh water put in every six or seven days, with roots of sweet flag and some moss. The flabby ones are sickly, and will not bite. To fix them to a spot, they should be put in a short tube, stopt at the remote end with the finger, and the tube withdrawn when they are fixed. The best draw but half a fluid ounce of blood; therefore, the quantity should be increased by warm applications. But when obstinate, the wound should be closed with a fine needle and thread. After disgorging their blood by applying a little salt or vinegar, they should be put in three or four clean waters to recover. Thomson thinks they gorge to apoplexy, and then fall off.

A new vessel of deal, large enough to contain sufficient water for 500 leeches, is to be furnished with a stop-cock, to draw off the water. It is to be half filled with the mud from the lake or pond whence the leeches have been taken, and two or three roots of the Florence iris are to be inserted in the mud. The usual precautions, as to temperature, frequent change of water, &c. are to be taken; the water is to be changed slowly, and the fresh water added, by means of a funnel descending to the bottom of the vessel.

LEEKS, are bulbs, expectorant and stimulant, containing a little sulphur. The juice is a powerful diuretic, dissolving the calculi formed of the earthy phosphates. *Wild Leeks*, in their leaves, partake the properties of garlic and leeks. In *Vine Leeks* the leaves are more heating than leeks. Diuretic and emmenagogue.

LEGHORN HATS.—It is chiefly in the neighbourhood of Florence, Pisa, the district of Sienna, and in the upper part of the valley of the Arno, that the best platting is made for straw hats. The straw used in working these mats is grown in districts mountainous and sterile. It is produced from a kind of wheat, of which the grain is very small. This straw, though slender, has much consistence, and the upper part of the stalk being perfectly hollow, is easily dried. It is pulled out of the earth before the grain begins to form. After being freed from the soil, which adheres to the root, it is formed into small sheaves, to be winnowed; the part above the last joint of the stem is then pluckod off, which is from four to six inches long, the ear remaining attached to it. This being done, it is bleached by the dew and the sunshine. Rain is very injurious to it, and destroys much of its whiteness. The lower parts of the straw are treated in the same manner, and employed in forming mats of an inferior quality. The upper parts, torn off just to the knot, are sorted according to their degree of fineness. This stapling is made with much care, and usually affords straw of three different prices. A quantity of straw, worth 4½*d.* after having undergone this process, is sold for 4*s.* 7*d.* The tress is formed of seven or nine straws, which are begun at the lower end, and are consumed, in plaiting, to within an inch and a half of the upper extremity including the ear. All the ends of the straws that have been consumed are left out, so that the ears are on the other side of the tress. As fast as it is worked it is rolled on a cylinder of wood. When it is finished, the projecting ends and ears are cut off; it is then passed with force between the hand and a piece of wood, cut with a sharp edge, to press and polish it. The tresses thus prepared are so used that a complete hat shall be formed of one piece. They are sewed together with raw silk. The diameter of the hat is in general the same; the only difference consists in tho degree of fineness, and, consequently, the number of turns which the tress has made in completing the hat: some having from twenty to eighty such turns.

LEGISLATION, or the science of law-making, for the regulation of society, bespeaks in the legislators a perfect knowledge of the society for which the laws are made, and a previous intermixture with the various classes of the people. Legislators, not so qualified by knowledge and experience, are in danger of committing great errors, or of making useless, irrelevant, or oppressive laws. It is evident, therefore, that no one is qualified to make wholesome laws, but those who constitute a part of the people, and whose knowledge of their wants and wishes results from actual experience. No legislator, therefore, ought to be under a certain mature age, as 35 or 40; and none ought to be chosen, who are not by habit part of the community which they are to represent and regulate. Those who live by administering the laws are least of all qualified to make laws, since the profits and power of their own profession is their primary object; and those who have usurped any privileges alien to the common interests of all, ought never to be chosen, since their chief solicitude will be the security and increase of their own privileges. In general, it has been the misfortune of mankind to have laws made by kings and conquerors, or by their favoured satellites, who are utterly ignorant of human nature in the details of life, and whose minds never having been urged by any necessity, are little qualified for any employment, much less for the delicate task of making salutary laws for a community. The absurdities and complexities of British laws arise entirely from the culpable negligence of constituencies, in returning improper persons to parliament! There is also great confusion in the discussions, as well as in the laws, owing to the multitude of legislators that compose our Houses of Parliament. In both houses there are 1058 opinions to be reconciled!

LEMON, (*Citrus*), one species of the genus, of which orange is another. The outer rind contains a fragrant oil. The juice is a very refreshing modification of citric acid with mucilage, sugar, and water. The trees produce thousands of the fruit. To keep, the juice is crystallized, and, when wanted, dissolved in any liquid. The essential oil is produced by distillation with water and alcohol. Ten gr. to half-scruple, is good for dropsy.

*Lemon Drops.*—Mix ½ lb. of sugar with 3 drs. of salt of sorrel in a little water, boil, add ½ lb. more sugar, and 8 drops of essence of lemon; *or*, (tartaric acid, and citric acid, for the sorrel-salt, and lemon;) then with a crooked wire draw it out in drops on a slab.

*Lemonade Powders.*—Mix, and divide into 24 parts, 6 oz. of sugar, 10 drops of essence of lemon, and 1 oz. of tartaric acid.

LENITIVE ELECTUARY.—Mix, well-together, 8 lbs. of senna-leaves, 1 lb. of figs, and ½ lb. of each of pulp of tamarinds, cassia, and French prunes, 2 lbs. of white sugar, 4 oz. of coriander seeds, and 3 oz. of liquorice. *Or*, mix 28 lbs. of treacle, with 10 lbs. each of raisins, prunes, and tamarinds, 4 lbs. of senna, 2 lbs. of coriander seed, and 1 lb. 8 oz. of liquorice. *Or*, (best) 10 lbs. of figs, and of cassia fistula, 7 lbs. of prunes and of tamarinds, 6 lbs. of senna, 4 lbs. of coriander seed, 2 lbs. 4 oz. of stick-liquorice, and 25 lbs. of white sugar.

LENSES, are round glasses, ground with convex or concave surfaces, and sometimes with one plane side. They are, in fact, mere multiplying-glasses, with an infinite number of sides, producing an infinite number of images, whose visual resultant is one blended figure, expanded over the whole visual angle of the glass, in length and in breadth, and therefore said to be magnified. The images produced by the inclined or oblique sides, owing to unequal refractions, are however highly-coloured in the focus; and, owing to the unequal inclinations of the spherical form, the rays do not all converge exactly to the same point. Lenses have therefore been very properly composed of two kinds of glass, which refract differently or unequally, and then, by combining a convex and a concave, the inequality is destroyed, and the image free from colour. The forms too have been varied from the spherical to the parabolic, with a view to concentrate the rays in one point. Lenses are manufactured with great precision, by steam-power, at Sheffield, Birmingham, and London, by Jenkins's machine, fixed in concave basins, and the friction proceeds on some hundreds at the same time. Superior glasses, with long focuses and large diameters, are wrought with great labour by hand. Large lenses, with long foci of flint glass, are very rare; but colour has latterly been destroyed by interposing a lens of dense fluid between the object and eye-glass.

LETTUCE, *(lactuca)* is a well-known wholesome salad, but the milky juice of its cut stem in flower, yields a narcotic extract, called *lactucarium*, much used as a mild variety of opium, in pills of one to six grains, or as a tincture.

Lettuces are deprived of much of their narcotic principle by tying them up, by which they are blanched.

LEVER, an inflexible bar or beam, whose principle of action, in varying motion, is the foundation of all mechanics, and all physical power: for the length on each side the fulcrum, determines the velocity of the ends, and when two weights produce a balance or equality of matter and motion, the forces are equal, or in equilibrio, and in that case, the weight multiplied by the distance in one, is equal to the weight and distance in the other. But, if unequal, and an equilibrium or excess is desired, a proportionate increase must be made. Levers as handspikes, iron crows, &c. are instruments of power, because we present the short arm to an obstacle, and then applying power to the long arm, we gain force as the long arm is to the short arm. All questions regarding levers have three things given to find a fourth in exact proportion.

LEVER of LAGAROUST, is a machine for rendering an alternating circular motion rectilinear. This is effected by two hooks, which catch the teeth of a central bar, as the lever works up or down at either end.

LEY, or LEES; a term usually applied to any alkaline solution made by levigating ashes that contain an alkali. Soap-lees is an alkali used by soap-boilers, or potash or soda in solution, and made caustic by lime. Lees of wine are the refuse, or sediment, deposited from wine standing quiet.

LI, a Chinese measure, of which nearly 200 are a degree. It contains 1800 Chinese feet.

LIAS, is an extensive series of thin strata of clay and limestone, lying immediately beneath the oolite, and above the coal strata, in which last vegetables appear, and in the lias, vertebrated and viviparous animals, in genera and species now unknown.

The upper portion of these deposits, including about two-thirds of their total depth, consists of beds of a deep-blue marle, containing only a few irregular limestone beds. In the lower portion, the limestone beds increase in frequency and assume the peculiar aspect which characterizes the lias, presenting a series of thin stony beds, separated by narrow argillaceous partings; so that the quarries of this rock, at a distance, assume a striped and riband-like appearance. These limestone beds, when purest, contain 90 per cent. of carbonate of lime; the residue consisting, apparently, of alumine, iron, and silex. The *blue lias*, which contains much iron, affords a strong lime, distinguished by its property of setting under water. The *white lias* takes a polish, and may be used for purposes of lithography. The *lias clay* often occurs in the form of soft slate or shale, which divides into very thin *laminæ*, and is frequently much impregnated with bitumen and iron pyrites; in consequence of which, when laid in heaps with fagots, and once ignited, it will continue to burn slowly until the iron pyrites is wholly decomposed. When it falls in large masses from the cliffs upon the sea-shore, and becomes moistened by sea-water, it ignites spontaneously. Lias clay is impregnated with common salt, and sulphate of magnesia and soda; in consequence of which, springs of water, rising through it, contain these salts in solution, and the Cheltenham and Gloucester springs are in this clay. The lias is remarkable for the number and variety of its organic remains, among which are numerous chambered univalves, bivalves, certain species of fish and vertebral animals, allied to the order of lizards, some of which are of enormous size.

LICHENS; a family of plants, belonging to the class *cryptogamia*, containing about 1200 known species, are under several genera. Their substance is powdery, crustaceous, membranous, coriaceous, or even corneous. They are common every where, adhering to rocks, the trunks of trees, and barren soil. On ascending mountains, they are found flourishing beyond the limit of all other plants, even to the verge of perpetual snow. Many of them, fixing upon the hardest rocks, by retaining moisture, facilitate their decomposition and promote the formation of soil. Several of the species are used for sustenance in times of scarcity, by the inhabitants of the northern regions.

Iceland moss is exceedingly abundant in the arctic regions, and often affords aliment to the inhabitants, either in the form of gruel or bread, which last is very nutritious. The taste is bitter, astringent, and extremely mucilaginous. It is frequently employed in pharmacy, in the composition of various pectoral lozenges and syrups, and is celebrated as an article of diet, in combination with milk, in coughs and pulmonary affections.

Orchil *(rocella tinctoria)* is also an important article, though less used now than formerly, on account of the fugitiveness of the rich purple, and rose-coloured dyes which it yields. Some of its tints, however, are capable of being fixed, and it is, besides, employed for staining marble, forming blue veins and spots. Several other lichens afford dyes of various colours, as litmus.

Lichen, Liverwort, or Algæ, are the stunted herbage of the arctic circle, and of barren heaths. In Iceland and Lapland, it is eaten in broth and milk, and even made into bread, its bitterness being removed by washing in hot waters. It contains much mucilage or gluten, and has been extensively used in pulmonary complaints, and as a demulcent, relieving cough, and correcting all acrid secretions.

LICHEN, or ORCHEL, or Argol, is another species, famous for its dye of purple, blue, violet, &c. It is chiefly produced in the Canaries, and is there ground in a mill, mixed with pearl-ash, urine, and potash, and sold in cakes. It is used to heighten colours, but is very evanescent, except when used with solution of tin, which gives to it a permanent red dye.

LIFE-BOAT.—An invention of Greathead, and found of great utility in situations in which ordinary boats would be swamped. If a spheroid be divided into quarters, each quarter is elliptical, and resembles the half of a wooden bowl, having *a curvature with projecting ends.* Such a vessel thrown into the sea cannot be upset, or lie with the bottom upwards, owing to the ends. The length is 30 ft., the breadth 10 ft.; the depth from the top of the gunwale to the lower part of the keel in midships, 3 ft. 3 in.; from the gunwale to the platform (within), 2 ft. 4 in.; from the top of the stems (both ends being similar) to the horizontal line of the bottom of the keel, 5 ft. 9 in. The keel is a plank of 3 in. thick, of a proportionate breadth in midships, narrowing gradually towards the ends, to the breadth of the stems at the bottom, and forming a great convexity downwards. The stems are segments of a circle, with a considerable rake. The bottom section, to the floor-heads, is a curve fore and aft, with the sweep of the keel. The floor-timber has a small rise, curving from the keel to the floor-heads. A bilge-plank is wrought-in on each side, next the floor-heads, with a double-rabbet groove, of a similar thickness with the keel; and, on the outside of this, are fixed two bilge-trees, corresponding nearly with the level of the keel. The ends of the bottom section form that fine kind of entrance observable in the lower part of the bow of the fishing-boat, called a coble, much used in the north. From this part to the top of the stem it is more elliptical, forming a considerable projection. The sides, from the floor-heads to the top of the gunwale, flaunch off on each side in proportion to above half the breadth of the floor. The breadth is continued far forwards towards the ends, leaving a sufficient length of straight side at the top. The sheer is regular along the straight side, and more elevated towards the ends. The gunwale fixed to the outside is three inches thick.

The sides, from the under part of the gunwale, along the whole length of the regular sheer, extending 21 ft. 6 in., are cased with layers of cork, to the depth of 16 in. downwards; and the thickness of this casing of cork being 4 in., it projects at the top a little without the gunwale. The cork, on the outside, is secured with thin plates or slips of copper, and the boat is fastened with copper nails. The thwarts, or seats, are five in number, double-banked; consequently, the boat may be rowed with 10 oars. The thwarts are firmly stanchioned. The side-oars are short, with iron tholes and rope grommets, so that the rower can pull either way. The boat is steered with an oar at each end; and the steering-oar is one-third longer than the rowing-oar. The platform placed at the bottom, within the boat, is horizontal, the length of the midships, and elevated at the ends, for the convenience of the steersman, to give him a greater power with the oar. The internal part of the boat next the sides, from the under part of the thwarts down to the platform, is cased with cork; the whole quantity of which, affixed to the life-boat, is nearly seven cwt. The cork contributes much to the buoyancy of the boat, and is a good defence in going alongside a vessel, and is of use in keeping the boat in an erect position in the sea, or rather for giving a very lively and quick disposition to recover from any sudden cant or lurch, which she may receive from the stroke of a heavy wave.

The boats, in general, of this description, are painted white on the outside: this colour being more conspicuous when rising from a hollow of the sea. The bottom of the boat is varnished. The oars are made of fir, of the best quality. In the management, she requires twelve men to work her, that is, five on each side, rowing double-banked, with an oar slung over an iron thole, with a grommet, so as to enable the rower to pull either way, and one man at each end to steer her, and to be ready at the opposite end to take the steer-oar, when wanted. The best method, if the direction will admit of it, is to head the sea. The steersman should keep his eye fixed upon the wave or breaker, and encourage the rowers not to give way, as the boat rises to it; being then aided by the force of the oars, she launches over it with vast rapidity, without shipping any water. When a wreck is reached, if the wind blows to the land, the boat will come in shore, without any other effort than steering.

Scheerboom and Co. have recently invented an apparatus, for converting any boat or vessel into a life-boat, in cases of danger, and it is recommended by high authorities.

LIFE-BUOY, used in the British navy, consists of two hollow copper vessels connected, each as large as a pillow, sufficient to support one man standing upon them. Should more than one require support, they can lay hold of rope beckets, fitted to the buoy, and so sustain themselves. Between the two copper vessels, there stands a hollow pole, or mast, into which is inserted, from below, an iron rod, whose lower extremity is loaded with lead, in such a manner that, when the buoy is let go, the iron slips down to a certain extent, lengthens the lever, and enables the lead at the end to act as ballast. By this means, the mast is kept upright, and the buoy prevented from upsetting. The weight at the end of the rod is arranged so as to afford secure footing for two persons, should that number reach it; and there are, also, large rope beckets, through which others can thrust their head and shoulders, till assistance is rendered. At the top of the mast is fixed a port-fire, calculated to burn about twenty minutes, or half an hour: this is ignited, most ingeniously, by the same process which lets the buoy fall into the water; so that a man, falling overboard at night, is directed to the buoy by the blaze on the top of its mast. The gunner, who has charge of the life-buoy lock, sees it freshly and carefully primed every evening. In the morning, the priming is taken out, and the lock uncocked.

LIFTING EXPERIMENT.—This new fact, lately developed in Italy, merits attention, owing to its illustration of physiological principles. If six persons draw a strong inspiration together, they can lift a seventh person lying on a table, with the tip of their fingers, and with slight exertion. But if they inspire together, and try to lift an equal dead weight, they fail; and, if the seventh does not inspire with them, he is a dead weight. This fact is only to be explained on theories of the Editor of this volume. When a man inspires, he converts oxygen into carbonic acid gas, and transfers to his system the *difference* of the momenta of their atoms. This is his vitality and vivacity, and power of counteracting the weight of his own parts. It is his strength, and that of the six. His frame is less heavy, relatively to its own parts. But, at the same time, the oxygen at the lungs is to them positive electricity; and, by contrast, the surface of the skin becomes negative, or nitrogenous. The one supplies oxygen to the arterial blood, and the other, nitrogen to the venous. The living system is the intermediate body of the animal. The seven, then, are as one body, and each, in the connection, is jointly effected. Electrical action and reaction counteracts weight; and, hence, the peculiar effect of this case.

LIFE-PRESERVERS.—These are in all forms, but one of the simplest is a ring of caoutchouc, large enough to go round the body under the arm-pits blown up with air. When full, the outside is nearly 2½ feet diameter, and the inner 18 inches; the diameter of the blown-air ring being 6 inches.

A belt of corks, sewed in canvas, answers the same purpose. The Chinese have a convenient contrivance of four pieces of light wood, with a square in the body to the arm-pits, similar to the above ring, and, of course, easily nailed or tied together, in a moment of danger.

LIGHT, in addition to the information under the head Candles, Combustion, &c. we have to mention the very astonishing action in producing waves of light, which arises from exposing a globule or pea of lime to ignition in a blow-pipe, consuming oxygen and hydrogen. It resembles the focus of a reflector in the sun, and has already been applied to the microscope, as a substitute for the sun, and by Lieut. Drummond, to the illumination of light-houses, instead of Argand burners. The ignition lasts from 15 to 25 minutes, when new globules are inserted. From a small ball, only three-eighths of an inch in diameter, so brilliant a light is emitted that it equals in quantity about 13 Argand lamps, or 120 wax-candles; while, in intensity or intrinsic brightness, it is 260 times that of an Argand lamp.. In the best of our revolving lights, such as that of Beachy Head, there are no less than 30 reflectors, 10 on each side. A single reflector, therefore, illuminated by a lime-ball, for each of these 10, is 26 times greater than that of the 30. This method was tried lately at Purfleet, in a temporary light-house, erected for the purpose of experiments by the Corporation of the Trinity-house, and its superiority over all the other lights with which it was contrasted, was fully ascertained and acknowledged. On an evening, when there was no moonlight, and the night dark, with occasional showers, the appearance of the Purfleet light, viewed from Blackwall, a distance of 10 miles, was very splendid. Distinct shadows were discernible, even on a dark brick-wall, though no trace of such shadows could be perceived, when the other lights, consisting of seven reflectors, with Argand lamps, and French lenses, were directed on the same spot. Another striking and beautiful effect, peculiar to this light, was discernible when the reflector was turned, so as to be itself invisible to the spectator; a long stream of rays was seen issuing from the spot where the light was placed, which illuminated the horizon to a great distance. As the reflector revolved, this immense luminous cone swept the horizon, and indicated the approach of the light, long before it could itself be seen from the position of the reflector.

The same balls have been substituted for sunshine, by Carey, Strand, in very powerful microscopes, and are constantly on exhibition in Old Bond Street.

By Rutter's apparatus, the usual experiments with the blow-pipe are infinitely more splendid and more impressive than can be effected by any other means; and the *lime* experiment, especially, is inconceivably brilliant, exhibiting a disc of pure white light, at least 1½-inch in diameter.

This, and every other experiment on light, proves the undulating theory; hence, there must be a medium, containing appropriate atoms and combinations, fit to produce light, wherever light travels; and, of course, such a medium in all the celestial spaces, even to the stellar clusters of Herschel, or they could not be visible.

LIGHT MATCHES.—Form a paste, by adding spirit of turpentine to two grains of vermilion, and half a scruple of flowers of sulphur, and chloride of potash. Dip the ends of the matches in spirit of turpentine, then coat with the paste, and dry well. In a phial, put some pounded asbestos, or fine sand, and moisten with sulphuric acid. The match is dipped into this, and when withdrawn, inflames instantaneously.

The first part of oxygenated matches consists in impalpably pulverizing the chlorate of potash, and intimately mixing the powder with flour of sulphur. A similar mixture violently detonates by percussion, or merely by the simple friction between two hard bodies, such as the pestle and mortar, or the muller and grinding-stone. The second part consists in making a thick fulminating mixture of the chloride of potash, sulphur, and nitre, by tempering them with a sufficient quantity of a weak solution of gum-arabic in water. Sometimes, manufacturers add a little vermilion; but its natural colour is a pale yellow.

*Detonating Matches* are those which, after being lighted by any means, at a certain period of their burning, make an explosion. These matches are more costly than the others; and, consequently, are only purchased by persons who know what they require. The preparation of these matches is simple: it consists in making, by means of a small gouge, an excavation in the stem of the match, at about a third part of its length, from the prepared end of it; and raising up the loosened part of the wood, introducing into the hole, made at the farther end, an atom, either of fulminating silver, or fulminating mercury, but especially the former; and then glueing up the small slice of wood raised by the gouge.

A chemist at Stockton-upon-Tees supplies prepared matches, which are put up in tin boxes, but are not liable to change in the atmosphere; and also with a piece of fine glass-paper, folded in two. A strong blow will not inflame these matches, because of the softness of the wood underneath; nor does rubbing upon wood, or any common substance, produce any effect, except that of spoiling the match. But, when one is pinched between the folds of the glass-paper, and suddenly drawn out, it is instantly inflamed.

*Prometheans* are small glass bulbs, filled with concentrated sulphuric acid, and hermetically sealed, and surrounded with a mixture of inflammable materials, amongst which the chlorate of potash forms one; and the whole being again inclosed or surrounded with paper, are rendered still more inflammable by means of resinous matters. Upon pinching the end containing the glass bulb, between the jaws of a pair of pliers, the bulb breaks, and the sulphuric acid instantly kindles the surrounding materials.

Dobereiner's discovery of the igniting action of a jet of hydrogen gas, when thrown upon a mass of spongy platina, is now employed in a variety of ways.

The kindling of *amadou*, or German tinder, by the sparks produced from the collision of a flint and steel, now so very commonly used in lighting segars, ought also to be included amongst the methods for producing instantaneous light.

Gill has improved upon this apparatus, by substituting a loosely-twisted cotton cord, steeped in a solution of pure nitrate of potash, for the German tinder, and which readily kindles by the sparks produced from the flint and steel. He did not, however, content himself with merely igniting the cord, and which required the use of a sulphured match, to obtain a light from it; but he also prepared the cord, by coating portions of it at regular intervals, alternately with sulphur, and then with wax; the sulphur readily kindles, of course, by the ignited match-cord, and as readily lights the wax; and thus a flame is produced by one operation only. This flame endures sufficiently long to seal a letter, and perform other temporary offices; and might even be prolonged, by thus preparing the wicks of wax-bougies or candles, of a greater length and thickness, with nitre and sulphur.

*Jackson's Instantaneous Light.*—Remove the plug of the stop-cock, and drop into the lower globe from a quarter to half an ounce of zinc, either in wire, or in pieces cut from a sheet of the malleable metal. Take off the loose cap, and pour through the upper globe a mixture of one part oil of vitriol with eight or ten parts water, in sufficient quantity nearly to fill the lower globe. As soon as a brisk effervescence commences, replace the plug, and allow the whole of the liquid to rise into the upper globe before making use of the apparatus. When the generation of gas ceases (which may be known by the liquid remaining in the lower vessel), remove the plug and cap, unscrew the jet, and pour off the liquid. Then, having carefully wiped the inside of the stop-cock, and moistened the plug with a minute quantity of oil, proceed to recharge it, according to the above directions. Should the jet become obstructed, unscrew it, and pass the point of a fine needle through it from the inner side, taking care not to enlarge the hole. The apparatus should be used once or twice a week, to keep it in order; and if it should not light readily, apply a candle to the jet, and the cause will easily be discovered.

LIGNIN, is purified wood. The hydrogen, in all, is from 5 to 6½ per cent. The carbon varies from 52 to 42, and the oxygen from 51 to 42. It is purified by being reduced to saw-dust, and then digested in various solvents, so as to abstract its foreign matters, as in water, alcohol, and some of the acids and alkalies. It then becomes white and opaque; but boiled with sulphuric acid and water, it forms, first gum, and then sugar.

LIGNUM-VITÆ TREE, (*Guaiacum.*) —The wood is resinous, hot, aromatic, diaphoretic. diuretic, and useful in dropsy, gout, and, in warm climates, venereal disease. It yields the gum guaiacum; the leaves are detergent, and used in scouring floors, and washing printed linens.

LIME, is a prot-oxide of the pure caustic alkali *calcium*, and still very caustic. Carbon neutralizes it as limestone. But the carbon, driven off by heat in the lime-kiln, renders it caustic again, something like its primitive *calcium.* Water then converts it into slaked lime.

Lime is obtained with most facility from the *native carbonate*, from which, by a strong heat, the carbonic acid may be expelled. This process is conducted on a large scale, with the different varieties of limestone, which are calcined or burnt, in order to obtain the caustic earth, or *quicklime.*

As mortar, the slaked lime re-absorbs oxygen, and again becomes carbonate of lime, or, in its office of cement, limestone. In slaking, 3 lbs. of lime absorb 1 ℔. of water.

The affinity of the carbonic acid in limestone is so much greater than for magnesia, that less heat in the limekiln converts magnesian limestone, or dolomite, into quicklime, than is required for ordinary limestone. With the same heat, dolomite, or magnesian limestone, loses more than half its weight; and carbonate of lime only half. But undue heat in the kiln converts either in glass.

Different carbonates of lime have 58, 57, 54 lime, 40, 47, and 42 carbonic acid, with fractions of sulphur, carbon, and iron. *Marle* is 50 carbonate of lime, 32 clay, 12 silex, and 2 iron and manganese. Hence its great use as a manure.

Lime for laboratory purposes is made either from white marble, or oyster-shells, by exposing them in a crucible for an hour. When water is poured on it, it becomes an hydrate or slaked lime, but the water may be re-expelled at a red heat. The hydrate is 75·68 lime, and 24·32 water.

If a little water only be sprinkled on new-burnt lime, it is rapidly absorbed, with the evolution of much heat and vapour. This constitutes the phenomenon of slacking. The heat proceeds from the consolidation of the liquid water into the lime.

Lime-water is made by pouring 12 ℔s. of cold water on half a ℔. of quick or unslaked lime. Stir, and cover it, let it stand three hours, and then bottle it. For dyspepsia and acidity it is highly beneficial, and it carries off mucus in the bowels.

When lime-water stands exposed to the air, it gradually absorbs carbonic acid, and becomes an insoluble carbonate, while the water remains pure. If lime-water be placed in a capsule, under an exhausted receiver, which also encloses a saucer of concentrated sulphuric acid, the water will be gradually withdrawn from the lime, which will concrete into small six-sided prisms.

Muriate of lime is made by the London College, by mixing two ℔s. of the residuum, after subliming subcarbonate of soda, with a pint of water, filtering and evaporating to dryness. Preserve in a stoppered bottle. Its solution with snow sinks the thermometer to 50 below zero.

Two oz. of lime, dissolved in 3 oz. of water, and filtered, is a valuable medicine in scrophula and bronchocele. From 1 gr. to 1 scr., in milk, two or three times a day.

Phosphuret of calcium, or phosphate of lime, is obtained in the following manner: a few pieces of phosphorus are placed at the bottom of a glass tube which is then filled with small pieces of lime. The part of the tube where the lime is, is heated red-hot; and the phosphorus is then sublimed by heat. Its vapour, passing over the lime, decomposes it, and a reddish-coloured phosphuret of calcium is formed. This substance is remarkable for decomposing water, whenever it is dropped into it, causing an immediate production of phosphuretted hydrogen, which takes fire at the surface of the water.

Chlorine combines directly with lime, forming the very important substance used in bleaching, formerly under the name of *oxymuriate of lime*, but at present called *chloride of lime*. It is formed by passing chlorine gas over slaked lime.—*See* Bleaching.

Lime, in its state of combination with carbonic acid, is a useful ingredient in soils. When lime, whether freshly-burnt or slacked, is mixed with any moist, fibrous, vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost. By this means matter, which was before comparatively inert, becomes nutritive; and, as charcoal and oxygen abound in all vegetable matters, the lime becomes converted into a carbonate. Mild lime, powdered limestone, marles, or chalks, have no action of this kind upon vegetable matter; by their action they prevent the too rapid decomposition of substances already dissolved; but they have no tendency to form soluble matter. Quicklime, in the act of becoming mild, prepares soluble out of insoluble matter. It is upon this circumstance that the operation of lime, in the preparation of wheat crops, depends, and its efficacy in fertilizing peats, and in bringing into a state of cultivation, all soils abounding in hard roots, or dry fibres, or inert vegetable matter. The solution of the question, whether quicklime ought to be applied to a soil, depends upon the quantity of inert vegetable matter it contains. The solution of the question, whether marl, mild lime, or powdered limestone ought to be applied, depends upon the quantity of calcareous matter already in the soil.

Lime is much used by tanners, skinners, &c. in the preparation of their leather: by soap-boilers, for dissolving the oil, and facilitating its union with the alkaline salt; and by sugar-bakers, for refining their sugar.

Limestone represents the greater part of the pure varieties of the species. The simple varieties, and those compound ones in which the individuals are of considerable size, and easily cleavable, have been called *calcareous spar*; compound varieties of granular, still discernible individuals, are *granular limestone*; both comprehended under the head of *foliated limestone*. If the granular composition disappear, *compact limestone* is formed, under which denomination, the *oolite*, or *roestone*, was comprehended. *Common fibrous limestone* is produced by columnar composition, in massive varieties; the *fibrous calcsinter*, by the same, but appearing in various imitative shapes. *Peastone*, or *pisolite*, consists of diverging columnar individuals, collected into curved lamellar ones, forming globular masses, which are again agglutinated by a calcareous cement. Compact limestone passes into *chalk*, when the individuals are more loosely connected with each other, so that the whole assumes an earthy appearance; and *rock milk*, or *agaric mineral*, is formed. *Calcareous tufa*, a recent deposit, formed on the surface of the earth, is often cleavable, and thus possesses all the properties of calcareous spar. *Slate spar* is produced by a lamellar composition, in massive varieties, and often exhibits a pearly lustre. *Swinestone*, *anthracolite*, *marle*, and *bituminous marlite*, are impure and mixed varieties, partly of calcareous spar, partly of compact limestone.

Limestone rarely enters into the composition of rocks: in most cases, the more considerable masses of it form particular beds in other rocks, or constitute rocks themselves; the latter consist chiefly, though not exclusively, of compact limestone; the former of granular limestone.

When coals are scarce, lime may be burnt with wood or peat, placed in layers in a conical form, covered with clay, and of 5 or 6 yards in diameter, with a funnel of dry furze and peat in the centre, of 2 feet in diameter. The pile is set on fire by the top of this funnel, which will burn down to the bottom and set the whole into combustion.

A pailfull of quicklime dipped in water, and then closed, gives heat enough to warm an apartment for a considerable period.

Boiling-water dissolves but 0·00078 of lime, and water at the freezing-point 0·00152.

Burnt, or slaked lime, is applied as manure, from 100 to 160 bushels per acre on light soils, and 200 to 250 for heavy cohesive soils. It should be in fine powder, be plunged in with a shallow furrow; is preferable for land in preparation for green crops to grass land; its second application to moorish land should be in compost, and on fresh land it is much superior to dung. It prepares soluble out of insoluble matter, and, when mild, operates as chalk. The land after it is more easily cultivated.

LINE, in decimal measures the 10th, and in duodecimals the 12th of an inch, French or English; the French inch being to the English as 1 to 1·065977.

LINIMENT OF AMMONIA, is a mixture of equal parts of olive-oil and caustic-water of ammonia. Excellent for sore throats, rheumatic pains, &c. A stronger liniment is, 2 olive-oil, with 1 solution of ammonia.

*Liniment of Camphor*, is 4 olive-oil, 1 camphor. The compound liniment is, 3 solution of ammonia, and 8 spirit of lavender distilled, and 1 camphor dissolved, with $\frac{1}{4}$ tincture of opium added.

*Liniment for Burns and Scalds.*—Take of borate of soda $1\frac{1}{4}$ dr.; rose-water 2 drs,; lime-water $2\frac{1}{2}$ oz.; oil of sweet almonds 3 oz. Soak lint in this mixture, and apply to the affected parts. Turpentine is also a good liniment, or any spirits.

LIP-SALVE, (*White*). Melt together equal weights of white wax, white sugar-candy, spermaceti, and olive-oil.

*Or*, (*Red.*) Melt together 4 oz. of white wax, 5 oz. of olive-oil, 4 drs. of spermaceti, and add 20 drops of oil of lavender, and 2 oz. of alkanet root. *Or*, 2 oz. of best olive-oil, 3 oz. of spermaceti and of white wax, with 4 drs. of alkanet root; melt, strain, and add 3 drops of oil of rhodium wood. *Or*, melt together 2 oz. of white wax, 3 oz. of spermaceti, and 6 oz. of oil of almonds, and add 1 oz. of alkanet root, and 2 drs. of balsam of Peru.

LIQUORICE.—*Glycyrrhiza glabra*, the plant which produces the liquorice of the shops is cultivated in England for the use of brewers and distillers, but liquorice is manufactured from it only in Sicily and Spain. It grows naturally near Pontefract and Languedoc, and in such abundance in Sicily that it is considered a great scourge to the cultivator. Its roots penetrate to a great depth, and the deeper the ground is opened, with a view to eradicate them, so much the more vigorous is the succeeding crop. The juice is expressed from the roots, in the same way as oil is from olives: they are first washed perfectly clean; then crushed in an olive-mill; then boiled four or five hours; pressed in the olive-press; and the juice slowly boiled, and evaporated in an iron vessel.

LISBON DIET DRINK, or the compound decoction of sarsaparilla, is made by boiling from 10 pints to 5, 6 drs. of sarsaparilla root, with 1 oz. each of sassafras root, guaiacum bark, and stick liquorice, and 3 drs. of bark of mezereon root. To drink 3 half-pints per day. This, and the decoction of the woods, are the very best family medicines; and, as tonics and stimulants, a gallon of either is superior to 20 of wine or spirits.

LITHARGE, is the crystals of melted lead left to cool, and is formed also in the refinement of silver. It removes acidity in wines, but renders them highly pernicious, and the use of it is deeply criminal.

LITHIUM, is a white alkaline metal, lighter than potassium, and its oxide is still an alkali called Lithia.

LITHOGRAPHY, consists of drawings made on stone, with ink containing soap. The design is then washed with nitrate of lime, which takes the alkali of the soap, and renders it insoluble. The stone is then washed with a solution of gum arabic, which repels the printing-ink from the stone. It is then worked with rollers, but the working is so costly as to diminish the use of the art in popular books. The nitrate of lime is made by pulverizing broken parts of the stone, and keeping the powder in aquafortis, till it ceases to effervesce. It is then diluted with rain or distilled water.—*See* ENGRAVING.

*Lithographic Ink.*—Soap, from suet or tallow, dry, 30 drs.; mastic, in tears, 30 drs.; soda, 30 drs.; shell-lac, 150 drs.; fine lamp-black, 12 drs.

To melt these materials, a copper, or cast-metal skillet, should be used. The soap is first put into this vessel, which is then to be placed over a brisk fire in a chafing-dish; when this is well melted, the shell-lac is to be thrown in, which will fuse very readily; the soda is then to be added, a little at a time; and after this the mastic, taking care to stir it with a spatula, furnished with a wooden handle; lastly, the lamp-black is gradually put in, stirring it between every successive addition, until the mixture is complete. When all these materials are well incorporated, they are poured out on a plate of cast-iron, made very warm, and rubbed over with oil, in order that the composition may be easily detached from it. Before the mass is poured on the plate, ledges are formed around it with pieces of wood, which serve to prevent the mass from running off, and enable you to preserve it of an equal thickness throughout: when these pieces of wood are removed, the composition is to be cut into strips, by means of a knife, which should be guided by a straight ruler; this must be done whilst the composition is warm. Little sticks are thus formed, similar to those of Indian ink.

*Or, Lithographic Ink* is composed of equal quantities of yellow soap and shell-lac, boiled, and burnt together in the usual manner, with a sufficient quantity of lamp-black added, to make it black; this forms a cake, which is to be rubbed up either with warm or cold water, in the manner of Indian ink. In extreme cases, where a mass of shade is condensed, a little acid may be used with good effect; and nitric acid diluted with water is the proper requisite.

*Transfer Paper* is thus made:—Take of tapioca and arrow-root, each a quarter of a pound; boil them to paste, and mix them, and with hot water make them into a thin paste, which strain through muslin; then stir into the paste a quarter of a pound of flake white, previously well ground in water. The paper, either thick or thin, should be half-sized. Then, with a flat camel's-hair brush, first lay a coat of common parchment size upon the paper, and let it dry in; then lay on the above paste, evenly, three times, but letting each coat be well dried between each time of laying it on. As soon as the paper is dry, it should be well cold-pressed, or be sent to the glazing-mill, and be flattened between iron rollers, which clears its surface; and the glazed part should be on the back-side of the paper, which is effected by rolling two sheets together, face to face. The work, drawn on the prepared face of the paper, is, if fine, to be executed with a steel pen; the dark parts are drawn with a common crow-quill.

*To Transfer.*—Let the stone be moderately warmed; then damp the back of the paper on which the work has been executed, until it lies perfectly flat; take care, however, that no wet touches the work; then lay the paper carefully upon the warm stone, and over it lay flat soft paper, which will absorb the wet on the back of the transfer paper. Now pass it through the press two or three times, with an increased pressure, after which, the paper will peel off, leaving the composition it was coated with, as well as the drawing executed upon it, on the stone. Wash off the former, and rub the drawing over with a coat of strong gum-arabic water. Lastly, lay it by till it has become cold, and then print from it.—*Trans. Soc. Arts.*

LIVER OF SULPHUR, is the union of sulphur with an alkali.

LIXIVIATION, is the washing of granulated bodies in a funnel, whose neck is obstructed by loose substances, through which the particles have to filter.

LOAM, contains 87 of sand as fine as meal, and 13 of clay.—*Kirwan.*

Loam is a natural mixture of clay and sand. The coloured clays and loams participate of iron; hence, many of these melt in a strong fire, without any addition; both clay itself, and mixtures of it with crystalline earths, being brought into fusion by ferruginous oxides, though the fusible mixtures of clay and calcareous earths are, by the same ingredient, prevented from melting. The bricks made from some loams, particularly the Windsor, are, when moderately burnt, remarkably free, so as to be easily rubbed smooth, cut, sawed, grooved, &c. Hence their use in building furnaces, &c.

LOCK, an improvement of the primitive latch or bolt, with a crooked stick or instrument, to turn it through a hole on the outside. Obstacles are opposed inside, and then the accommodating the key to pass them, constitutes its wards, the object being merely to turn and unturn a bolt, now called locking and unlocking. On the number and complication of the obstacles in carrying the key to the bolt, so as to turn it, depend the perfection of the lock. The spring-lock consists of the main-plate, the cover-plate, and the pin-hole. In, and on the main-plate, is the key-hole, the top-hook, the cross-wards, the bolt-knob, the tumbler and its pin, and the staples. To the cover-plate is affixed the main, cross, and step-wards, and the pin. With the pin-hole are connected the hook, cross, and bow-wards, and the bit. The best locks are made in England, and in Staffordshire. French locks are despicable. Bramah's is the most esteemed; but there are Spears', Taylor's, and a dozen others. The Americans are beginning to excel in locks, as well as in all other mechanical articles, the best hands having left England after the destruction of the capital of credit by the panic of December, 1825.

LOCO-MOTIVE CARRIAGES, or steam-carriages, are an artificial imitation of animal power, and, then the application of this power to wheel-carriages. Animal power is the condensation or fixation of oxygen gas in the lungs, and then the distribution of the imparted motion of the gas through the nerves, muscles, and limbs, which, by directing the force to the ground, and making a purchase by friction, enables an animal to move onward, and drag a weight. A locomotive carriage, in like manner, by fire expands water, generates steam, and a vacuum, and the atmospheric pressure a force for turning a wheel against the ground; or, on Fordham's plan, air previously condensed, by force seeks re-expansion by equal force, and this is made a means of turning a wheel, and producing locomotion. Till lately, it was not imagined that the mere purchase of friction was sufficient to make the carriage follow the wheel, or enable the wheel to drag a weight; therefore, the machinists of the last age conceived the limit of locomotive power on land to be cogged wheels, working in the fixed teeth of railways; or, they imagined, that some leverage, pushing against the ground, was necessary, by reaction, to produce locomotion. Under this error, Blenkinsop, of Leeds, took out a patent for propelling apparatus, and rail-ways were constructed with rack-work, and plans for station-houses, to act by chains and ropes, were promulgated by ingenious persons. It was believed, and no one dared to doubt it, even that paddle-wheels, in steam-boats, would turn round without effect, and that carriage-wheels would do the same, unless armed with some peculiar means of purchase.

At length, both these errors were dissipated by successful experiments; but, down to the middle of 1832, steam-carriages have made little progress, for want of capital, all the capital of the country being absorbed by Jews and stock-jobbers; and all enterprise being destroyed by the pernicious monetary policy of the state.

The power is applied to two of the four wheels, and, in fact, one is sufficient. But every turn of the wheel or wheels corresponds to a stroke of the piston, and to a consumption of a double cylinder of steam. That is, every revolution of a wheel, about four yards, requires two cylinders of steam, at a power of expansion varying from 20 to 50; and it cannot be too often repeated, that the first power is that of the oxygen fixed by the fire.

An engine, travelling 32 miles on the rail-way, in 100 minutes, from Liverpool to Manchester, and drawing 100 tons, in a train of 20 waggons, consumes about 1000 lbs. of coke, or 33 lbs. per mile, or a third of a lb. per ton per mile. The speed, aided by a gentle fall, is 25 miles, and on a rise 16 miles; but they often travel 30 miles, and have gone 35.

In the engines for turnpike-roads, the boilers themselves have been multiplied, and the water has been distributed in numerous tubes, so as at once to give the highest power to the fire, and diminish the danger of explosion. This is the principle of Hancock's and other boilers, and Mr. Hancock's consists of plates in separate vessels, capable of bearing very high pressure, but worked at only a fourth or fifth, or 50 or 60 lbs. to the square inch.

The air-tubes have been lessened in size, and increased 150 in number; so that the utmost economy of a coke-fire, aided even by bellows, has been adopted. Nevertheless, a pertinacious ignorance of the nature of combustion, and of the real causes of its power, and various absurd theories on that and other subjects, have, to this time, encumbered the construction.

In the trial of loco-motive steam-carriages at Liverpool Rail-way, in October, 1829, Braithwaite's carriage, including water and fuel, weighed 3 tons 14 cwt. Stephenson's carriage 4 tons 3 cwt., with water and fuel, in a separate carriage, 1 ton 14 cwt. 3 qrs. Stephenson's carriage ran from 14 to 17 miles an hour, and sometimes 18. Braithwaite's ran 21 miles 1-6th, and with 45 passengers. In a train of waggons, in a second experiment, it went 22 miles an hour, and occasionally 32 miles.

| | |
|---|---|
| The carriage alone was | 2 tons 15 cwt. |
| Forty-five gallons of water, in boiler, 10 lbs. | 4 |
| Water, in tank | 11 |
| Water-tank | $2\frac{1}{2}$ |
| Coke | $1\frac{3}{4}$ |

Which, with weight added by the judges, made 10 tons.

In January, 1832, Mr. Fordham, at the Royal Institution, gave an account of a new method of transferring the power of water-mills, stationary steam-engines, or other cheap first-movers, to loco-motive engines and carriages. His proposal is, to compress air by the power of these motors, and then to employ its elastic power in propelling the carriages. The air may be condensed by the power of steam-engines, water-mills, or any other cheap prime mover, and, when condensed, it may be contained in strong but light iron vessels, called recipients; a certain number of which, fixed in a frame, and opening into a common main pipe or tube, will be a reservoir. Each reservoir is taken to contain a quantity of condensed air, sufficient to propel a carriage of a certain weight, one stage of eight or ten miles. The carriage, in its appearance or external form, will resemble a steam-boat in miniature. The wheels will support, and also give motion to, the vehicle: the reservoir will be suspended beneath the axle; and the bottom of the frame should not be more than nine inches from the ground. The machinery will consist of two or more cylinders, with pistons, connecting rods, and the apparatus for communicating motion, which is commonly used in high-pressure steam-engines. The valves must be made to close at any part of the stroke, for it is necessary to let the air expand in the cylinders, and it will be advantageous to let the air pass from one cylinder to the other; working in each or all expansively; and permitting it to escape from the last into the external atmosphere. With these conditions in view, a carriage for conveying the mail and four passengers may be made of 42 cwt., and the rate of travelling may be 14 miles an hour; the expenditure of air on 10 miles being 2000 cubic feet, with a reservoir to hold upwards of 3000.

A carriage, intended to convey 20 passengers and luggage, may be made on the same plan, but the proportions will be different, and the weight 84 tons.

The rate of travelling would be at least 10 miles an hour, and the expenditure of air 4000 cubic feet, the reservoir containing 6000.

The expense of compressing the air will vary; but, in general, it may be stated that the power of steam, produced by the combustion of one bushel of coals, will condense 2000 cubic feet of air, under a pressure of 36 atmospheres, or 480 lbs. to the square inch.

This is certainly a new view, and highly interesting, since, in condensed air, we have a magazine of power, formed at leisure and convenience, and used as wanted for this or for any purpose. The common air itself then becomes the relative vacuum. But we have not yet heard of any carriage on Mr. Fordham's plan.

Besides Mr. Hancock and Mr. Gurney, Messrs. Ogle, Brathwaite, Church, and Trivithic, have constructed very efficient engines for common turnpike-roads; and, in spite of coach-masters, horse-dealers, oat-growers, &c., and of the schools and endowed professors of science, we may expect soon to see the general establishment of this mode of conveyance on every road. If Fordham's condensed air-engines can be brought into use, and the cumbrous machinery for generating the power from fire in the carriage be avoided, and the carriage be merely a machine for expending accumulated power, lomo-motive engines will be perfect.

LOCUST, a predaceous insect, so voracious and numerous in Asia as to produce extensive famines. In return, they are eaten by the Arabs, Egyptians, &c.; and are as great a delicacy as prawns or shrimps, which they resemble in form.

LOCUST (*robinia pseudacacia*) is a valuable tree, which grows wild, in great profusion, among the Alleghany mountains and throughout the Western States of North America. When in bloom, the large pendulous racemes of fragrant white flowers, contrasting with the light-green foliage, produce a fine effect, and give this tree a rank among the most ornamental. The wood is compact, hard, capable of receiving a fine polish, and has the valuable property of resisting decay longer than any other. The colour is greenish-yellow with brown streaks. Locust-posts are every where preferred, when they can be obtained; and this wood is also very much employed in ship-building, in the upper and lower parts of the frame. For tree-nails, it is preferred to all other kinds of wood, as it acquires extreme hardness with age. It is also employed by turners, and, from its fine grain and lustre, forms a very good substitute for box. The usual stature of the locust is 40 or 45 feet, but it sometimes reaches the height of 80 feet with a trunk 4 feet in diameter. The *R. viscosa* is a smaller tree than the common locust, from which it is distinguished by its rose-coloured flowers.

LOG; a machine used to measure the

rate of a ship's velocity through the water. It is a piece of thin board, forming the quadrant of a circle of about six inches radius, and balanced by a small plate of lead, nailed on the circular part, so as to swim perpendicularly in the water, with the greater part immersed. The log-line is fastened to the log by means of two legs, one of which is knotted, through a hole at one corner, while the other is attached to a pin, fixed in a hole at the other corner, so as to draw out occasionally. The log-line, being divided into certain spaces, which are in proportion to an equal number of geographical miles, as a half or quarter minute is to an hour of time, is wound about a reel. The whole is employed to measure the ship's head-way, in the following manner:—The reel being held by one man, and the half-minute glass by another, the mate of the watch fixes the pin, and throws the log over the stern, which, swimming perpendicularly, feels an immediate resistance, and is considered as fixed, the line being slackened over the stern, to prevent the pin coming out. The knots are measured from a mark on the line, at the distance of 12 or 15 fathoms from the log. The glass is, therefore, turned at the instant that the mark passes over the stern; and, as soon as the sand in the glass has run out, the line is stopped. If the glass runs 30 seconds, the distance between the knots should be 50 feet. When it runs more or less, it should, therefore, be corrected by the following analogy: As 30 is to 50, so is the number of seconds of the glass to the distance between the knots upon the line.

LOG-BOARD; two boards shutting together like a book, and divided into several columns, containing the hours of the day and night, the direction of the winds, and the course of the ship, with all the material occurrences that happen during the 24 hours, or from noon to noon, together with the latitude by observation. From this table, the officers work the ship's way, and compile their journals.

LOG-BOOK, is a book into which the contents of the log-board is daily transcribed at noon, together with every circumstance, deserving notice, that may happen to the ship, or within her cognizance, either at sea or in a harbour, &c. The intermediate divisions or watches of a log-book contain four hours each.

LOG-HOUSES, in America, are strictly such, being built of round logs of the felled trees laid upon one another, and the interstices filled with slips of water and clay, or mortar. This is followed by the frame-house, consisting of morticed frames, covered with boards, inside and out, and painted white or red. They consist, in general, of a sitting-room and kitchen, with four or five bedrooms, all on the ground-flour, with spacious cellaring.

LOGWOOD, in decoction, is useful in diarrhœa, when taken in a wine-glass every two or three hours. It tints the urine red.—*See* Dyeing and Colours.

LONGEVITY, is a term usually applied to cases of great age, from 80 and upwards, and, in some very rare cases, as high as 150 or even 170. The mean term of life in England, as men are now fed, lodged, and cloathed, and as diseases are by modern science treated, relieved, or cured, is about 40 years, and the Carlisle table makes it 41 years and 6 weeks.

But longevity is partly a result of family constitution, partly of habit of life, and partly of accident.

When we hear of very aged persons, we hear also of their children of approximate age, and, in many families, 80 or 90 is the average; while, in others, it is only from 30 to 50.

Regular habits, especially in diet, contribute to extension of life. The stomach is the primary organ; the animal hydatid, to which the limbs, the respiratory organs, the circulations, and the medullary system are merely auxiliary; and the life of this organ proceeds by the appropriation of the mobility of the atoms of atmospheric gas, and by the assimilation of atoms from natural food. Stimulants are exactly like combustibles put on a fire, or like manure in soil, which, in excess, either blaze out quickly or consume the roots of the plant. Vegetation converts mineral matter into food for animals; and, hence, an increase of longevity usually accompanies a simple vegetable diet.

And the half of all deaths are occasioned by external or internal accidents. Some fatal practice suddenly destroys, or some undue exertion diseases, a vital organ.

Life is, however, desirable no longer than it can be enjoyed; and the wearing out of the system, in advanced age, causes, in general, more pains than pleasures; while the hopes and passions, which give it zest in youth, vanish with the animal powers.

THOMSON'S LONGITUDE SCALE, may be purchased of any of the opticians; and, the distance of the moon from a star being measured by a sextant, it resolves the longitude in the simplest manner, without calculation, on one side; while the other side facilitates the determination of the latitude by the altitude of an heavenly body.

LOOMS, are machines for crossing and weaving threads. The two materials are the warp and weft, crossed and matted by a shuttle, carrying the weft. There are many forms, for different fabrics and materials; and, next to the plough, the loom is the most useful of machines. Till lately, they were universally worked by hand.

The estimated number of looms propelled by water and steam power, in the United Kingdom, in 1830, was, 58,000. The average produce, taking it at 22 square yards a day, weekly, 7,524,000; monthly, 31,300,000; yearly, 376,200,000. In 1833 they are, probably, full 80,000.

LUCK AND ILL-LUCK.—Many men are infatuated by impressions about their luck or ill-luck, as though the events of all past time, the progress of the earth in its orbit, and all nature, had reference to their puny concerns. Prudence and moderation in expectations, are luck; want of calculation and inordinate desires, generate ill-luck. But gamesters are assured of luck and ill-luck. This depends, however, on their stakes or passions, not on the cards or dice. These exactly balance in a given number of throws or deals. If a man throws true dice 100 times, an equal number of aces, deuces, &c. will come up. Or, if he deal four hands, at cards, 100 times, every hand will have had an equal number of the suits, of court-cards, and trumps. 200 will bring it nearer to equality than 100. The same with chairs, &c. There is, therefore, no other luck or ill-luck than in his stakes, which are quite independent of the cards or dice.

LUTES AND COATINGS.—For the highest degrees of heat the best coating is *Stourbridge's clay*, made into ductile paste; pressed very close and even in every part, and dried gradually. *Windsor loam*, of clay and sand, is used for lining furnaces, &c. *Willis's lute* is an ounce of borax in a pint of boiling water, with slaked lime, for a paste; to be spread with a brush, with a finish of slaked lime and linseed-oil. *Fat lute* is pulverized clay, with drying linseed-oil. *Glazier's putty* is also used. *Parker's cement* resists a red heat, and is often used for glass retorts and tubes; and *plaster of Paris*, in a thick cream, sets very solid. *Caustic lime*, with various substances, as white of egg or glue, is much used. *Iron cement* is 1 part sulphur, 2 sal ammoniac, and 80 iron, rammed into joints. Linseed-oil, caoutchouc, glue, yellow wax, &c. &c. *cup cement* is five parts resin, one bees'-wax, one red ochre; and *soft cement* is yellow wax and half turpentine, with Venetian red.

The most common luting is that made by triturating, in a mortar, fine clay and linseed-oil, for heat, or one pipe-clay three fine sand well kneaded; but bees'-wax, melted with an eighth of turpentine, answers for cold operations. Glass vessels, truly ground, often do without luting, or, for some purposes, wet leathers or caoutchouc, in slips or dissolved in turpentine, for no air, moisture, or gas, penetrates the thinest sheet of caoutchouc.

LUNA CORNEA, or HORN SILVER, is made by mixing solutions of nitrate of silver and salt, and the precipitate, melted at 500°, becomes horn silver.

LUNAR CAUSTIC.— *See* NITRATE OF SILVER.

LUNGS, the organs of respiration, situated in the chest, and divided into two parts, called *lobes*. They are enveloped in a delicate and transparent membrane, derived from the pleura, through which they have the appearance of net-work, and are connected with the spine by the pleura, with the neck by the wind-pipe, and with the heart by the roots of the pulmonary artery and veins. They are the lightest of all the animal organs. In their internal structure, they are composed of an infinite number of membranous celled blood-vessels, nerves, and lymphatics, all connected by cellular substance. The cells communicate with each other, but have no communication with the cellular substance: small tubes arise from them, which are finally united into one large tube from each lobe; and these two at length join to form the windpipe. The blood-vessels, called the *pulmonary* vessels, are destined to distribute the blood through the cells, for the purpose of subjecting it to the action of the air; while the bronchial vessels are intended to supply the blood which nourishes the lungs. The cetacea (whales, seals, &c.) breathe by lungs, and are, therefore, obliged to ascend, at intervals, to the surface of the water, to obtain a supply of atmospheric air. The respiratory orifice, in these animals, is not situated at the extremity of the snout, but on the top of the head. In birds, the lungs are smaller than in quadrupeds, but they have air distributed throughout their muscular system, and in the cavities of the bones.

The lungs afford a means of ascertaining whether a new-born child, which is found dead, was or was not living, when born. The lungs of the infant are placed in water, to see whether they will swim or sink. Before birth, the lungs are dark red, contracted into a small place within the cavity of the breast, firm, and specifically heavier than water. They, therefore, sink in water, whether they are entire or cut into pieces; and when cut, no air-bubbles come forth, either in or out of the water, nor does much blood appear. But if the babe has lived after birth, and therefore breathed, air has entered the lungs, has thus enlarged the cavity of the chest, and the lungs themselves are expanded, appear of a loose spongy texture, of a pale red colour, cover the heart, and fill the chest. They then swim in water, as well in connexion with the heart as without it, as well entire as in pieces.

LYCOPODIUM POWDER, is used by ridiculous demons in theatrical mummeries, to make flashes of flame, since it burns, on passing through a lighted torch, by a jerk of the hand.

MACERATION, is the pouring of either hot or cold water upon a substance, and leaving it to stand.

Maceration, is insertion in cold water or spirits. Digestion in hot. Infusion is in hot liquid. Decoction is continued heat or boiling. Extract is the evaporation of the water from an infusion or decoction.

MACHINERY. The utility of machinery consists in the addition which it makes to human power. The forces derived from wind, water, and steam, are so many additions to human power, and the total inanimate force thus obtained in Great Britain has been calculated to be equivalent to 20,000,000 labourers. Instead of working himself, man makes nature work for him, and, in that degree, ought to be enabled to live as well, and work less himself. The effect ought, in this respect, to ease the whole community, or it ceases to be an advantage. On the contrivance of every new tool, human labour is abridged. The man who contrived rollers quintupled his power over brute matter. A tool is usually a more simple machine, and generally used by the hand; a machine is a complex tool, a collection of tools, and frequently put in action by inanimate force. All machines are intended either to produce power, or merely to transmit power and execute work. All the mechanical powers are, in effect, levers.

In the *wheel* and *axle*, the wheel is the long arm, the axle the short arm, and their ratio or division is the power.

In the *pulley*, one gives no power, but two gives double the velocity of the power; three treble, and so on, exactly on the lever principle.

The *inclined plane* operates as a lever, because the distance moved on the plane is greater than the heighth gained; hence, the power is as the length of the plane to the heighth.

The *wedge* is another lever, on the same principle as the inclined plane, but varied in power by resistance.

The *screw* is a lever, in which the power moves through the entire circumference, while the obstacle moves only through the distance of the threads.

Friction diminishes the results, but, in general, a fourth or fifth more power is applied than the calculation demands, to compensate for friction, and other causes of loss of power.

When two bodies balance each other by means of any machine, and are then made to move, the product of each into its velocity, *i. e.* the quantities of motion or momentum ascending and descending perpendicularly will be equal.

The quantity of power in motion is the velocity multiplied into the quantity of matter or number of atoms. Thus, a cubic inch of lead, moving 1 yard per second, has a momentum of 1; and 2 cubic inches a momentum of 2; or 1, moved 2 yards, a momentum of 2. But a cubic inch of stone, but half the density of lead, would, in yard per second, have but half the momentum of the lead; and two cubic inches of such stone must move twice as fast as the lead, to have the same force or momentum.

Hence, universally, velocity, bulk, and density, must be multiplied together for momentum; and, if we diminish one we must increase one of the two others, or both, to have the same momentum. Animal, or other force, often stands for bulk and density, and then these must be varied as velocity.

As we increase velocity, with the same power we increase momentum; and, as we decrease velocity, we must increase power, to get an equal momentum.

This is the foundation of all mechanical science and practice, however varied, or complicated; and this principle being understood, we may, by the aid of common arithmetic, be able to pursue every useful mechanical object.

It sometimes happens, as in chemistry, that the power is invisible; but, in these cases, if there is power, it is not the less matter and motion. Invisible atoms are concentrating, or are dispersing, or are moving one among another in such cases. We often understand their action, and sometimes do not; but our ignorance, in particular cases, creates no alteration in the general laws of nature.

To determine the relative velocity of a body moving in any angle from the direction of the moving force, multiply the velocity conferred by the moving force by the natural cosine of the angle, and the product is the velocity in the angular direction. And, to find the perpendicular distance of the two lines, multiply the angular velocity by the sine of the angular deflection, and the product is that distance. The relative lengths of the three lines is the measure of the force in each.

In cases of double or more forces, if lines are drawn from one another to represent all the forces at their angles, the resultant force is the line which completes the figure.

When the work to be done requires more force for its execution than can be generated in the time necessary for its completion, recourse must be had to a fly-wheel, which is a wheel having a heavy rim, so that the greater part of the weight is near the circumference. Another method consists in raising a weight, and then allowing it to fall. And another in condensing air, by great force, and then using its expansive force as required.

Uniformity in the motion of machinery is essential. The governor, in the steam-engine, and a vane or fly of little weight, but large surface, which revolves rapidly, and soon acquires a uniform rate by the resistance of the air, are contrivances for steadying power.

*Increase of velocity* is effected by a band, passing round a large wheel, and then round a small spindle.

*Diminution of Velocity* is effected by systems of pulleys, or by transmission through a number of wheels.

Spreading the action of a force exerted for a few minutes over a large time, is one of the most useful employments of machinery, and the half-minute which we spend in winding up a watch, is an exertion of force which, by the aid of *a few wheels*, is spread over 24 hours.

Machinery affords a sure means of remedying the inattention of human agents, by instruments; for instance, for counting the strokes of an engine, or the number of coins struck in a press. The *tell-tale*, a piece of mechanism connected with a clock, in an apartment to which a watchman has not access, reveals whether he has neglected, at any hour, to pull a string in token of his vigilance.

The precision with which all operations are executed by machinery, and the exact similarity of the articles made, produce economy in the consumption of all raw materials.

The accuracy with which machinery executes its work is, perhaps, one of its most important advantages. It would hardly be possible for a very skilful workman, with files and polishing substances, to form a perfect cylinder out of a piece of steel; but this process, by the aid of the lathe and the sliding-rest, is the every-day employment of hundreds of workmen.

The objections to machinery arise from the faulty distribution of its benefits to society, and the neglect and gross injustice of not indemnifying those whose skill and capital is destroyed by new inventions.

It is computed that there are, in Great Britain, steam-engines as under, with the annexed horse-power, doing the work of the assigned number of men at six for a horse.

| *Engines.* | | *Power.* | | *Men.* |
|---|---|---|---|---|
| 20 | ...... | 200 | .... | 24,000 |
| 50 | ...... | 100 | .... | 30,000 |
| 100 | ...... | 80 | .... | 48,000 |
| 300 | ...... | 50 | .... | 90,000 |
| 400 | ...... | 40 | .... | 96,000 |
| 600 | ...... | 30 | .... | 108,000 |
| 600 | ...... | 20 | .... | 72,000 |
| 600 | | 10 | | 36,000 |
| 1000 wind-mills | | 20 | .... | 120,000 |
| 2000 water-mills | | 30 | .... | 360,000 |
| 5000 horse-mills | | 2 | .... | 60,000 |
| | | | Men | 1,044,000 |

The 2670 steam-engines actually employ three men each on the average, or 8010 men.

The wind-mills 2 or 2000
The water-mills 2 or 4000
The horse-mills 2 or 10000

24010

Hence, the labour 1,020,000 is saved.

Then, taking their labour at 20*s.* per week, this is a profit of 52 millions per annum in all the productions of machinery. But out of the profits is to be deducted 15 per cent. on the capital sunk in machinery. Then, taking the 2670 steam-engines at 600*l.* each, 1,602,000*l.*; the 2000 wind-mills at 300*l.*, 600,000*l.*; the 2000 water-mills at 400*l.*, 800,000*l.*; and the 5000 horse-mills and horses at 150*l.*, 750,000*l.*; in all, 3,750,000*l.*; the interest is 550,000*l.*, leaving a net profit of 51½ millions nearly.

Every steam-engine, then, employs, on the average, 80 men, women, and children, equal to 213,600; and the other 8000 mills 3 each, on the average, or other 24,000. So that employment connected occupies 263,600.

Marshall estimates the manufacturing population at 400,000 families, of 5½ each, or 2,200,000. If, then, 3 in each are so employed, this gives 1,200,000, of whom about 263,600 are connected with the operations of machinery. Some may rate the 80 at 100, which would add 53,400, and, perhaps, 500 of the mills, as those for paper-making, &c. may employ 30 instead of 3, which would add other 13,500, or together, 66,900 to 263,600 = 330,500 as the full number that may be considered as employed by machinery, and to be regarded as one-third more to be added to the products of machinery, with many advantages of speed, facility, and regularity.

Machinery is, therefore, in the production of cheap manufactures for exportation, and even for home consumption, to be regarded as a public benefit. But there are two parties, in regard to the advantages and disadvantages of machinery. The political economists, who consider society in the abstract, and look to general results, are partizans of all means which produce at the least cost, and, therefore, of machinery. So, also, inventors, or their assignees, who manufacture cheap, and, for a time, sell at the established price, or with such small abatement of the manual price as secures the market, thereby making vast profits. But the working artizan, who, by a machine, is thrown out of an employment by which he and his forefathers have long subsisted, and other manufacturers, who find themselves undersold and their trade destroyed, are enemies of all new machinery. The one is unable to learn a new trade, or to excel in it in the maturity or decline of life, and has no reserved capital, on which to subsist in the intermediate period; and the other, having embarked his capital in peculiar connections, finds it difficult, and even impossible, to withdraw it and establish any new and profitable business—so that the first are generally reduced to pauperism and the latter to bankruptcy. It is with each an individual—a personal affair, for which there is no compensation in the general benefit arising to the community, or in the aggrandisement of the inventor. Nevertheless, the community do benefit immediately and remotely, and it is, therefore, contended, that the community are thereby qualified to indemnify the immediate sufferers, and that laws and arrangements ought to be made, so as to effect this just and desirable purpose. This would reconcile the conflicting interests; inventions would then be more numerous and better encouraged, and a fair and reasonable componsation from the public stock would reconcile all parties to the progress of inventions and machinery.

MADDER.—The madder from Holland is most esteemed, and it is cultivated in that country to a great extent. In powder, it is of an orange-brown colour, but is liable to become damp, and to be spoiled, if kept in a moist place.

Madder is used for dyeing woollen, silk, and also cotton goods, and the colour is very lasting, and resists the action of the air and sun. Within a few years, a method has been discovered of rendering the red exceedingly brilliant, and appoaching to purple. It also forms a first tint for several other shades of colour, and, besides, has of late been successfully used by painters, and is found to yield a fine rose-colour. Madder also possesses the singular property of imparting its red colour to the bones of those animals which have used it for food, and also to the milk of cows, if they have eaten of it freely.

All the parts contain a yellow colouring matter, which, by absorption of oxygen, becomes red; the root is, however, most productive in this colouring matter, and is the only part employed in dyeing. It is distinguished into three parts—the bark, the middle portion, and the interior woody fibre. In the middle part of the root, which contains the finest colouring matter, and in largest quantity, there may be distinguished, by the microscope, a great many shining red particles, dispersed among the fibres. These constitute the rich dyeing material. The roots are, in commerce, dried and in powder; but they are also sold fresh; in which state they yield finer colours, dye more, and give up their colouring matter with one-third less water. According to experiment, 5 lbs. of fresh roots go as far as 4 lbs. of the dry ones; and it is estimated that 8 lbs. of fresh roots are reduced to 1 lb. in drying.

The differences in madder dyes proceed from the relative proportions of two distinct colouring principles in madder, which they have called *alizarine* and *xanthine*. By digesting the powder of madder in water, and acting upon the jelly-like solution thus obtained, by boiling alcohol, an extract is afforded, which, at a subliming heat, yields the proper red colouring matter of madder, or alizarine. Or the ground madder may be treated directly with boiling alcohol; and to the alcoholic solution, dilute sulphuric acid is added, which precipitates the alizarine in a copious orange precipitate. Alizarine has a golden-yellow hue, is insoluble in water, soluble in alcohol and ether, is precipitated by acids, but not by alkalies, showing distinctly an analogy to resins.

The xanthine is obtained from a fawn-yellow matter, soluble in alcohol and water, by precipitation with oxide of lead, washing the precipitate with alcohol, and extricating the colour by sulphuric acid. It has an orange-green tint, and a saccharine taste; alkalies cause it to pass into red, and acids to lemon-yellow. In those fabrics which exhibit rose-tints, the xanthine predominates; while, in the violet, it is nearly wanting. From a knowledge of these facts, it becomes easy for a skilful dyer to promote the absorption, by the cloth, of one or other of these colouring principles, or to remove one of them, should both together have been attached to it.

The ordinary madder-red dye is given in the following way :—The yarn, or cloth, is put into a very weak alkaline bath, at the boiling temperature; then washed, dried, and galled; or, when the calico is to be printed, for this bath may be substituted one of cow-dung, subsequent exposure to the air for a day or two, and immersion in very dilute sulphuric acid. In this way the stuff becomes opened, and takes and retains the colour better. After the galling, the goods are dried, and alumed twice; then dried, rinsed, and passed through the madder-bath. This is composed of three-fourths of a pound of good madder for every pound weight of the goods. The bath is slowly raised to the boiling-point in the course of 50 or 60 minutes, more or less, according to the shade of colour wished for. When the boiling has continued for a few minutes, the stuff is taken out, washed slightly, and dried a second time in the same manner, and with as much madder. It is then washed and dried, or passed through a hot soap-bath, which carries off the fawn-coloured particles. Other dyes, likewise, are added to the madder-bath, to obtain other shades of colour; for instance, a decoction of fustic, weld, log-wood, quercitron, knoppern, the mordants being modified accordingly.

Hoelterhoff prescribes, for ordinary madder-red, the following proportions: 20 lbs. of cotton-yarn, 14 lbs. of Dutch madder, 3 lbs. of gall-nuts, 5 lbs. of alum; to which are added, first $1\frac{1}{2}$ lb. of acetate of lead, and, subsequently, $\frac{1}{4}$ lb. of chalk. When bran is added to the madder-bath, the colour becomes much lighter, and of a more agreeable tint.—Adrianople madder-red is given by many distinct operations. The first consists in cleansing or scouring the goods by alkaline baths, after which, they are steeped in oily liquors, brought to a creamy state by a little carbonate of soda solution. Infusion of sheeps'-dung is often used as an intermediate, or secondary steep. The operation of oiling, with much manual labour, and then removing the superfluous or loosely-adhering oil, with an alkaline bath, is repeated two or three times, taking care to dry hard after each process. Then follows the galling, aluming, maddering, and brightening, for removing the dun-coloured principle, by boiling at an elevated temperature, with alkaline liquids and soap. The whole is often concluded with a rosing by salt of tin.

The root is astringent, diuretic, emmenagogue, and aperitive, and used in the rickets. The dose, in powder, is 1 scr. to $\frac{1}{2}$ dr.; or, of the decoction, 2 oz. daily.

MAGNESIA, is seldom found native, but is now made from the bittern, or liquor, which remains after the crystallisation of sea-salt. This being chiefly muriate of magnesia, it is only necessary to boil it, and infuse some carbonate of potash or subcarbonate of ammonia, when the new combination precipitates the magnesia, which, dried in square moulds, is the light magnesia of the shops. It consists of 44 magnesia, $36\frac{1}{4}$ carbonic acid, and $19\frac{3}{4}$ water. Its sp. gr. is 0·3, and heat expels the carbonic acid. The sulphate is Epsom salts.

Magnesia is separated from Epsom salt-spring water by adding an alkali: for, the sulphuric acid uniting in preference with the alkali, the magnesia falls.

*To make Carbonate of Magnesia.*—Dissolve four parts of sulphate of magnesia, and three parts of subcarbonate of potash, separately, in twice their weight of water, and filter them. Then mix them with eight times their weight of boiling water. Boil and stir, and then stand till partly cool; when, being strained through linen, the carbonate remains. Wash it and dry it gradually. It is the best anti-acid in the stomach, and the acid renders it purgative.

*Calcined Magnesia* is magnesia burnt in a crucible for two hours, so as to drive off all its carbonic acid.

MAGNESIAN LIMESTONE, or Dolomite, for the first name involves an incongruity, is carbonate of magnesia 46·5, carbonate of lime 52, with 1 of iron and manganese. *Or*, magnesia 20·3, lime 29·5, combined with 47·2 of carbonic acid, and 1 of iron and alumine. Another is 36 carbonate of magnesia and 62 carbonate of lime. The magnesia is separated by the bittern or mother-water of salt-works.

MAGNETIC NEEDLE, or MARINERS' COMPASS, is a steel needle, rendered magnetic, which, in the same place, for several years, points to the same part of the horizon, or, rather, turns in a plane inclined to the horizon. At London, at this time, it points to 24° west of the north, called *the declination;* and turns in a plane 70° inclined to the horizon, called *the dip*, or inclination. This plane is called *the plane of the magnetic equator*. At other places both the declination and the dip are different, but the differences are regular and recorded in tables.

Since the discovery of the fact that a current of electricity, in restoration, places the poles at right angles, and renders needles magnetic; and that while electricity produces magnetism, this, in its turn, reciprocates in action, and produces electricity. No doubt has existed that the cause is electrical, and that electrical current, generated by the terrestrial motions, turns the needle in the manner indicated. A number of absurd theories have hitherto darkened and mystified the subject, but we seem to have attained certainty so far; but h owthe peculiar plane is generated, and how it varies, as to itself, is still involved in obscurity. So many philosophers are, however, engaged on the subject, that, in a very few years, we may expect it will be thoroughly understood.

Magnetic power may be communicated from a magnet to another body capable of receiving the magnetic power, by mere touching. Every piece of iron attracted by a magnet becomes, to a degree, magnetic, but ceases to be so if it is removed from the sphere of action of the magnet. Iron, however, may be rendered permanently magnetic, either by communicating to it the magnetic virtue of the earth, or by the aid of proper magnets (natural or artificial.) The first effect takes place on iron (particularly bars of soft iron,) placed for some time in the magnetic line. All that is required is, that the iron does not deviate at too great an angle from the line: hence iron bars, which hang in the magnetic meridian horizontally (as iron balance-beams) grow magnetic; also iron bars which, in regions distant from the magnetic equator, are placed perpendicularly. In the northern hemisphere, the upper end becomes the south pole, the lower end the north-pole; in the southern hemisphere the contrary takes place. The communication of magnetic virtue in this way is promoted by giving to the iron bars a tremulous motion by hammering or boring: under such circumstances, even hard iron may become magnetic. Red-hot iron, growing cold in this position, also becomes magnetic. Tongs and fire-forks, by being often heated, and set to cool again in a posture nearly erect, have gained this magnetic property. The other way of communicating magnetic power, by rubbing iron with a magnet, is the most commonand most effectual. Hard iron receives magnetism in this way with more difficulty than soft iron, but retains it longer.

Steel, sufficiently hard, may be rendered permanently magnetic, while soft iron can never be made so. Take a steel bar, eight inches long, half an inch wide, and an eighth of an inch thick; put the north pole of a magnet in the middle of the bar, and draw it to one end; return, without touching the bar, to the point where you began, and draw again down to the end. Do this from 10 to 20 times. This part of the bar is now the south-pole; the other end the north-pole. The artificial magnet is strengthened, if the other half of it is rubbed in the same way with the south-pole of the original magnet. This process is called the single stroke. Another way, called the double stroke, is to put both the poles of a magnet in the middle of the bar, and to draw the magnet, without changing the direction of the poles, several times from one end of the bar to the other, taking away the magnet, finally, at the middle of the bar. A third way is that of the circular stroke. Four steel bars are placed so as to form a square, upon which the opposite poles of two magnets are drawn round several times.

A magnet is in no degree weakened by communicating its power to iron or steel, but no magnet can give more strength than it possesses; yet, if a steel bar is rubbed with several magnets united, it receives more power than belongs to each single magnet. Thus, by the connexion of many magnets, artificial magnets of very great power may be obtained. By these methods, masses of iron-dust and oil may be rendered magnetic.

When, by joining the ends or poles of wires connected with the positive and negative spheres of an electrical disturbance, these spheres flit through the direction of the wires, they affect, at right angles, all bodies near the wires electrify them and needles permanently. If, one side the wire, the positive hemisphere gives one kind of polarity, and if the other side, the negative hemisphere gives the other kind; and both at right angles to the wire. On the other hand, if ready-formed magnets are brought in similar positions as to a wire at right angles, their action developes electricity in the wire.

There can be no doubt but the terrestrial phenomena are somehow connected with the poles of the ecliptic and equator, and have some relation to the rotation and progression of the solid nucleus of the earth, which is more massive on the Asiatic side than on the opposite, and hence the inclination of its own axis. The dip is 90° in Baffin's Bay, indicating a peculiarity in the current, considering it as always at *right angles* to the cause.

Iron differs from other metals only in retaining the electrical charge; and since steel is more permanent than iron, we may refer it to the laminæ and carbon. Nickel and cobalt have similar powers, but less intense.

The Rev. Mr. Scoresby, late of Liverpool, has proved, by experiment, the singular fact that a steel bar may be rendered strongly magnetic by placing it nearly in the magnetic meridian and equator by declination of 24° west and a dip of 72½°. He then connects it with a bar of large iron, and strikes it several sharp blows at the end with a hammer, by which it at once acquires polarity and magnetizing properties.

*To deprive a magnet of acquired magnetism* is one of the ingenious inventions of Mr. Abraham, of Sheffield. He applies the opposite pole of a larger magnet, and by approaching it, and moving it from side to side for a few minutes, he effectually destroys its previous magnetism.

*To make a magnet stand at right angles (W. and E. or E. and W.) to its usual position.*—The fact was discovered by Oersted, but the cause is first stated in this Volume. If the connected wire, in contact at the poles of a galvanic battery, is placed over a needle, in the same direction, it instantly makes the needle turn at right angles in one direction; but if the needle is placed over the wires, it turns, at right angles, in the very opposite direction. This arises from the wire, while *in contact*, having two inductive currents, one above, in one direction, and one below, in the contrary direction, producing contrary effects above and below. The first effect is owing to that *sphere* of induction which ALL electrified bodies possess in tension and not in motion; but when in the motion of restoration, both kinds have their own *hemi*-sphere, (one being neutralised,) which hemisphere is, in effect, the restoration. And as the needles are oblique, or on one side, either above or below, the action of the inductive hemispheres is oblique, and the angle of deviation varies proportionally. The needles also have their spheres at their north and south poles, and these, being incompatible with the hemispheres of the wires, are placed at right angles to them. Hence, the existence of magnetic action bespeaks simultaneous electricity at *right angles*—both being electrical.

*To make a needle magnetical by galvanism.*—Twist the connecting-wire of the poles into a helix, and place in it a thick needle or bar of steel; while contact continues, break the contact, and the needle or bar is magnetic. The helix, by surrounding it, equally electrifies every part and its atoms, for innumerable cells in galvanic excitement; so that, broken any where, the parts have perfect north and south poles.

Mr. Marsh, of Woolwich, has exhibited a very powerful magnetic apparatus, in which, by a current of voltaic electricity, conveyed from a pile contained in a vessel not larger than a half-pint mug, so powerful a magnet was formed, that it suspended between five and six hundred weight.

*To destroy a ship's reaction.*—Messrs. Barlow and Lecount both announced, at the same time, the discovery of the cause of the action of a ship's iron on a magnet, and published a means of preventing or neutralising it. The cause is the different direction of the head of a vessel, as to the magnetic meridian, and the remedy is the placing of an iron plate between the compass and the acting bodies of double their force. In 1820, Barlow, of the Academy, Woolwich, proved that, in every unmagnetised iron body, there is a plane which may be considered its equator; that when the centre of a magnetic-needle is placed in this plane, the iron does not attract it; when it is above it, it suffers a directly contrary attraction to that which it does when it is below it; and that this plane is at right angles to the dipping needle. This plane of neutrality being constant, while the ship herself varies her position, she will necessarily present, at one time, north-poles towards the compass, and at other times south-poles, from the same piece of iron; in fact, while every piece of iron in her is found to vary in its effects on the compass, according to the position in which it lays, all these effects are referable to this one law, that a plane passing through their centres of attraction, in a direction at right angles to the dipping-needle, will divide them into north and south polarity, and that this polarity will instantaneously be reversed by reversing the ends of the iron body.

Mr. Barlow conceived the centre of this mass of attraction generally to be situated before and below the binnacle in which the compass is placed; if, then, in a line joining this centre of attraction and the needle-pivot, there is placed *a plate of iron*, removable at pleasure, and the distance of it from the compass is so determined by experiment that it just doubles the effect of the before-mentioned iron bodies, it is plain that the alteration which the application of this plate is found to make on the compass, whenever it is applied, is just that quantity which the iron in the ship had on it before, and that the course is to be corrected by the quantity which the plate thus causes the compass to deviate.

Dr. Faraday has succeeded in devising an easy method by which the spark from the natural magnet can be rendered clearly visible. From a small bar of iron, about nine inches long, were raised the connecting wires at right angles, and which, by another perpendicular bend, were made slightly to overlap each other, the undermost terminating in a disk about the size of a penny-piece. By a moderate, but rapid percussion of the bar against the natural magnet, the disk and overlapping wire were separated by their elasticity, and a brilliant violet-coloured spark made its appearance, which is clearly visible in the strongest light.

MAHOGANY EARTH, is pale red, from the Isle of Wight, and used in painting, and to stain mahogany colour.

MAIZE, like the other cerealia belongs to the natural family gramineæ, being neither more nor less than a gigantic grass. It is annual and herbaceous. The root is fibrous; the stems rise to the height of from four to ten feet, and, like other grasses, are furnished with knots at intervals. A great number of varieties are cultivated, differing in the size, hardness, number, and colour, of the grains, the form of the spikes or ears, and, what is a very important circumstance to the human family, in the time required to bring them to maturity. Some varieties require five months from the time of sprouting for the perfect maturity of the grains, while the period of six weeks is sufficient for others. It is usually ranked the third grain, in point of utility, next after rice and wheat. In some parts of America, two crops are obtained in a season; but, as it is found to exhaust the soil very soon, it is usually planted upon the same piece of ground only after an interval of five or six years. It succeeds best in a light and slightly humid soil. The spikes or ears are gathered by hand, and the husks, when perfectly dry, stript off, and, together with the stalks, laid by for winter fodder, while the ears are conveyed to the granary. The green stems and leaves abound in nutricious matter for cattle. The corn, when well dried, will keep good for several years, and preserve its capability of germination. It is eaten in various manners in different countries, and forms a wholesome and substantial aliment. Domestic animals of every kind are also extremely fond of it. According to Rumford, it is, next to wheat, the most nutritious grain. Mixed with rye-meal, it forms the common brown bread of New England; mixed with water alone, it makes a very palatable species of extemporaneous bread.

MALIC ACID, is made from the juice of apples and mountain ash.

MALLOW, Common, *Dwarf Mallow*, *Curled-leaved Mallow*, *Vervain Mallow*, *Musk Mallow*, are eminently emollient and moistening, proper to cool and open the bowels. The flowers are pectoral. *Marsh Mallows* are particularly used in diseases of the bladder. The seeds of the *musk* mallow are used in coffee, and mixed with hair-powder.

MALTHA, is a bitumen, still less fluid than petroleum, from which it differs in no other respect. Its principal locality is at Puy de la Pège, in France, where it renders the soil so viscous, that it adheres strongly to the foot of the traveller. It is also found in Persia and in the Hartz. It is employed, like tar and pitch, on cables and in calking vessels: it is used, as well as petroleum, to protect iron from rusting, and forms an ingredient in black sealing-wax.

MALT, is made from barley soaked in water, till it turns reddish, then drained, spread from one to two feet thick on a floor, where it heats, and emits its root or spike. It is then spread thinner for two or three days, again heaped up, until it heats, and finally dried on a kiln, and the roots separated by screening. 5 lbs. of spring barley produce about 4 lbs. of malt. Malt is used to make an alterative analeptic infusion, and its decoction is fermented to form beer and ale.

In the sweating process of malting, after four days, a thermometer in it rises 10° above the atmosphere—an effect of the atomic motion, from the decomposition of the parts, while sprouting, which, at the same time, evaporates the moisture in each grain. If not spread, the sprouting and heat proceeds rapidly, the gluten and mucilage are abstracted by the root, and the kernel becomes mealy.

Kiln-drying stops the germination, and, at 119°, produces white malt, at 134° amber, at 148° brown, at 171° coffee colour, and at 176° black. In mashing, the pale permits less heat in the liquor than higher colours. Barley, in malting, loses one-fifth of its first weight.

The grains of 100 lbs. of raw grain, after malting and brewing, weigh 55 lbs. and of 100 lbs. of malt, 54 lbs.

Wort, evaporated, gives a treacle like residuum of sp. gr. 1·552.

If 60 bushels of malt yield $23\frac{1}{2}$ barrels of worts, sp. gr. 1·0683; and they are boiled down to $19\frac{3}{4}$ barrels, or a sixth, the sp. gr. is 1·089.

If 72 bushels yield 15 barrels, sp. gr. 1·072, and it is boiled to 13, the sp. gr. is 1·106.

Good ale requires 1 lb. of hops to a bushel of malt, and weaker but $\frac{3}{4}$ lb. Too long boiling evaporates the aroma of the hops.

Every kind of grain will make beer, if half germinated, so as to acquire the saccharine quality; and it may be germinated either by burying it, or by water and heat, in the manner of malting.

A grain of barley weighs two-thirds of grain (0·681,) and its cubic contents is the 500th of a cubic inch (0·00217.) Barley-corns yield 5 husk, 19 meal, and 3 volatile matter. The mean length of various kinds is 0·3385 of an inch, or 20 to 7 inches; but when our long measure was settled, it was taken as 0·3333, or 3 to the inch. A bushel weighs from 50 lbs. to 50½ lbs.

Worts of 1·07 sp. gr. give ale of 1·0285, with 25 lbs. of saccharine. Of 1·08, ale of 1·03, with 24·3 lbs. Of 1·09, ale of 1·042, with 38 lbs. Of 1·1, ale of 1·042, with 36 lbs. Porter wort is 1·0645, and the porter 1·015. Brown stout 1·01.

About one-fourth of ale evaporates in cooling from 200° to 52°.

*Patent Malt* is malt kept heated to 130°, until it acquires a dark chocolate colour, and then used to colour beer: 1 lb. with 79 of pale malt, gives the colour and flavour of porter.

MALT SPIRITS. These may be highly improved by putting 3½ oz. finely powdered charcoal, and 4½ oz. ground rice into a quart of spirits, and letting it stand 15 days, frequently shaking it; then let the liquor be strained, and it will be found equal to brandy.

MALT WINE, or *beer without yeast or open fermentation*, called HOT BREWING.—For a hogshead, mash three hours, and boil, in the usual way, using 4 bush. of malt to 2½ lbs. of the best hops. Excite the activity of the bitter of the hops, by just covering them with boiling water, and then run the wort upon the prepared hops. Boil the whole an hour and a-half and strain out half the hops. Then put the boiling wort into the upright cask in which it is intended to be kept, leaving at least six inches in a hogshead vacant, as room for fermentation, which may be ascertained by boring a vent-hole in the side, six or eight inches down or level with the proposed top of the liquor, till no more runs out at the hole. Bung it up at once and peg it very tight. Admit no air, and in four or five months it will be ripe, and be very delicious and exquisitely-fine malt liquor. The casks must, of course, be strong, and be no way disturbed; and, without due care in leaving a space at top, the bottom, or any weak part, will give way. Another mashing, for table beer, may follow, with similar treatment. The Editor is indebted, for this concise and improved mode of brewing, to Mrs. William Atkinson, of Charlton-House, Wilts, who, with her connections, have practised it for some years. It resembles the superior mode of fermenting wine in close vessels, lately invented in France, by another lady, and, of course, the method preserves the aroma of the ingredients, and the flavour and strength are consequently exalted and improved.

MAN, the head of the monkey and ape tribes in stature and intellect; gregarious, like the rest, but with more refined powers of articulation, by which, agreement in resisting and assailing other animals is promoted. It appears, by the organic remains, that the earth's surface has, during successive epochs, been in possession of sundry tribes, among which the lizard, crocodile, and other amphibia, long prevailed, and some of sizes which justify the traditions and legends of antiquity, in regard to huge dragons, serpents, &c. Hands and speech, with vertebra strong enough to maintain the erect position, enabled the human tribes to emerge from the woods and caves, and first with clubs, bones, and missiles, and then with metallic cutting weapons and shields, to wage war on the previous occupants of the soil. Success led to enclosures, cultivation, metallurgy, manufactures, the domestication of the camel, horse, sheep, dog, &c.; and finally and successively, in countless ages, to all the present arts of life. But after men had subdued other genera and species, some sought to enslave others of their own race: and hence the various selfish monopolies, combinations, and artifices, of the social state; and also the frightful abuses of man's ascendancy, in the cruelties practised with impunity on subdued or helpless races of animals.

In the Cyclopædia of Practical Medicine, *Dr. Roget* has introduced an admirable essay on the physiological phenomena of old age. The progress from the gelatinous fœtus till the general ossifications of senility is admirably displayed. The organization, in arriving at maturity, hardens, in all its parts, and continues to do so till the flexibility is destroyed. We may add to Dr. R.'s paper, that the desiccating principle resembles the ordinate of a curve, and the expanding and conservative principle the abscissa, the ascending and descending curve being the fluxion of life, with different lengths as the original proportions vary, and in parts governed by the radii of curvature. The definite size which he treats as miraculous, is an arithmetical result of constant eliminations, opposed to constant accretions, whose series arrive at a limit which they cannot pass while governed by two laws of this kind. The curve and the series are exact representations of all the phenomena of life, from the worthless weed to the sycamore, or the ephemeron to the elephant.

Dr. Roget says, that the parts formed out of the cellular tissue, as the membranes, ligaments, tendons, and cartilages, exhibit the first symptoms of condensation and contraction. The muscles and the fibrous parts become tougher, and the muscles are converted into tendons. Ossification follows, in various membranes, in the coats of the blood-vessels, in the coverings of the viscera, and in the tendons and cartilages; while the bones themselves become harder and more brittle. Osseous tumours even take place in various parts of the body, and bones unite which were originally separate. The fibres lose their flexibility and the intervertebral cartilages, deprived of this property, cause the body to stoop and shorten. In a word, the fluids, the blood, &c. are dimiuished in quantity, and phosphate of lime increases. There is less perspiration, less lymph; the veins increase, while the arteries are diminished. The cuticle is thicker and drier, the *corpus mucosum* is darker, and the *cutis vera* is denser, tougher, and less flexible, producing wrinkles and shrinking of features. Gray hair results from the destruction of the bulbous capsule from which the hair is formed. Impaired muscular power and diminution of fluids destroy next the vision, while the absorption of the fluids in the ear leads to incurable deafness.

The diminution of muscular contractility affects the powers of the stomach, the heart, and the bladder, and subjects them to various fatal diseases.

The brain, from being semi-fluid at birth, condenses, hardens, and even ossifies, scarcely filling the cranium. The nerves and ganglions become harder, and less in size. Sensibility, in consequence, diminishes, pain is less acute, contagion less operative. Memory of recent events fails, and names are remembered with difficulty. At length, the failure of functions, from internal causes, leads to death; if not, as more generally, accelerated by some organic disease in the heart, the brain, or the respiratory organs.

The sense of duration, we may add, changes with experience. Time is a relative sensation, measured as present by past events. It is a series whose numerator is 1, and denominator the term of life less 6 or 7, when impressions begin to rest on the mind. At 8 it is $= \frac{1}{8-7}$, at $9 = \frac{1}{9-7}$, at $20 = \frac{1}{20-7}$, and at $85 = \frac{1}{85-7}$, or 6 times less than at 20. Different employments may vary the mental estimate, but such is the law.

MENAGERIE, was originally applied to a place for domestic animals, with reference to their nurture and training; but it now means any collection of animals. Daubenton, and other distinguished naturalists, have believed that the ferocity of many of the carnivorous animals may be entirely conquered in the course of time; that they only flee from man through fear, and attack and devour other animals through the pressing calls of hunger; and that the association with human beings, and an abundant supply of food, would render even the lion, the tiger, and the wolf, as manageable as our domestic animals.

MANGANESE, is a metal, like iron, with a sp. gr. of 8. But it is so alkaline that it will not endure in air as metal, and becomes violet, brown, gray, and black oxide. It is found most abundantly as the gray oxide. but also black, as a sulphuret, a phosphate, and a silicate. The black, or peroxide, is found in Devonshire, Cornwall, and near Dublin, with sp. gr. 3·5 to 4·5, having $71\frac{1}{4}$ manganese, and $28\frac{3}{4}$ oxygen. By parting with its oxygen it converts muriatic acid into oxymuriatic or chlorine. Its equivalent is 44.

Manganese is found surcharged with oxygen, 2 ℔s. containing 3 oz. Burning with charcoal reduces it to 1 atom manganese, and 1 oxygen. When quite de-oxydized, its sp. gr. is 8·013; but it so rapidly absorbs oxygen, that, like potassium, it decomposes air and water. It keeps when alloyed with iron. When two atoms of manganese are combined with five of oxygen, manganese acid is formed, of bright red; and, dissolved in water, and carbonic acid passed, it turns violet and brown. The red oxide is 3 manganese and 4 oxygen.

MANGE, is cured by a mixture of 1 sulphur, 4 nut-oil, boiled till the oil is reddish-brown. Add 4 oz. of oil of turpentine. Apply it with a feather.

MANGLE, is a machine for pressing heavy linen after washing. The linen, &c. is wrapped round rollers, and these are passed, backward and forward, under a heavily-loaded case. The best are those in which the winch turns but one way, the motion being reversed in the geer when the case has run home.

An improved mangle has been made by which linen may be both ironed and mangled at the same time. It is worked by a moving table, which passes under a pressure of $1\frac{1}{2}$ ton; and the operation may be performed by a child of eight or nine years old. The machine does not occupy a space of more than eight superficial feet, and the weight of the whole is not more than 2 cwt.

MANGOLD WURZEL, a root cultivated for feeding cattle in the winter months. About 3 or 4 ℔s. of seed are drilled or dibbled per acre, in May, and the distance be 18 or 24 inches. The produce, however, is so great, that an acre will keep 12 or 13 cows, at 60 pounds per day, for five months.

The advantages of mangold wurzel are these:—It is more sure to plant, being very little liable to the fly or grub: it will produce more weight; it is off the land earlier; it is useful as a change of fallow crop, when the land is exhausted by turnips; it will grow on land where turnips cannot be raised; it is better spring food.

MANIHOT.—Two kinds are cultivated in the colonies, the sweet cassada of *Browne's Jamaica* and *Manihot Aipi*, whose root is of a white colour and free from deleterious qualities. The bitter cassida, or manioc. has a yellowish root, and abounds in a poisonous juice. By various processes, by bruising between stones, by a coarse rasp, or by a mill, the root of the manioc is broken into small pieces, then put into a sack, and subjected to a heavy pressure, by which all the juice is expressed. What remains is cassava, or cassada, which, if properly dried, is capable of being preserved for a great length of time. In French Guiana, according to Aublet, cassava flour is made by toasting the grated root over the fire, in which state, if kept from humidity, it will continue good for 20 years. Cassava-cake, or cassava-root, is the meal, or the grated, expressed, and dried root of the manioc, pounded in a mortar, passed through a coarse sieve, and baked on flat circular iron plates, fixed in a stove. The particles of meal are united by the heat; and, when thoroughly baked in this manner, form cakes, which are sold at the markets, and universally esteemed as a wholesome kind of bread. The Spaniards, when they first discovered the West Indies, found this in general use among the native Indians, who called it cazabbi, and by whom it was preferred to every other kind of bread, on account of its easy digestion, the facility with which it was cultivated, and its prodigious increase. Again, in Guiana, cipipa is another preparation from this plant, and is the name given to a very fine and white fecula, which, according to Aublet, is derived from the expressed juice of the roots, which is decanted off, and suffered to rest for some time, when it deposits an amylaceous substance, which requires repeated washing.

The root of the Manioc is also the basis of several kinds of fermented liquors; and an excellent condiment for seasoning meats, called cabion or capion, is prepared from the juice, and said to sharpen the appetite. The leaves, beaten and boiled, are eaten after the manner of spinach; and the fresh root is employed in healing ulcers. The expression of the juice from the root deprives the latter of all its deleterious properties; and that the application of heat to these juices renders their residue also wholesome and nourishing. And whilst cassava-bread is, as Sloane says, in the most general demand of any provision all over the West Indies, and is employed to victual ships, the use of tapioca is still more extended, and throughout Europe is employed for the same purposes as sago and arrow-root.—*Curtis's Bot. Mag.*

MANGO; a celebrated fruit, now produced in most of the tropical parts of the globe. The taste is delicious, slightly acid, and yields only to the mangosteen. It attains the height of 30 or 40 ft., has a rapid growth, and is very productive. The fruit is kidney-shaped, subject, however, to a good deal of variation in size, form, and colour, and contains a large flattened stone. More than 80 varieties are cultivated, some of which are very beautiful, and diffuse a delightful perfume.

The mango has been fruited both in France and England. If a stove, or part of a stove, were fitted up for them, there can be no doubt but that the mango may be had on the table as easily as the pine-apple.—*Curtis's Bot. Mag.*

MANGOSTEEN, a far-famed fruit, is the product of a middling-sized and beautiful tree, the *garcinia mangostana*, and was originally brought from the Molucca islands, but is now cultivated in many parts of the East Indies. It is, on all hands, admitted to be the most delicious, as well as the most wholesome, of all known fruits.

The mangosteen is one of the most delicious fruits in the world, and it requires the same treatment as the mango. To these may be added the jambosteen, rambosteen, and decku; they are natives of the Oriental Archipelago, and, when obtained, might be cultivated along with the preceding.

MANNA IN TEARS, is that which flows spontaneously from manna ash-trees, and dries upon the bark; mostly the fraxinus rotundifolia; but, in less quantity, by the F. ornus, F. excelsior, and F. parvifolia; also by the plum, oak, and willow.—*Flake Manna*, hangs in stalactites from straw, &c. bound round a tree in June and July. Manna is laxative, in a dose of 2 scrs. to ½ oz. for children, or double for adults, in milk or any other liquid. *Common Manna*, flows from incisions, made after the 1st of August, in Sicily.—*Briançon Manna* is found on the leaves of the larch, in Dauphiny.—*Arabian Manna*, the *Manna of Moses*, is exuded, in June, from a species of tamarisk, growing in the desert, and only collected at early dawn, as it melts in the heat of the day, and runs into the sand. It is white and solid, if kept cool, but melts by the heat of the hand. It is sweet, aromatic, and very scarce.—*Persian Manna* exudes from the Hedysarum alhagi, and is used as a purgative.

MANURE.—Since all vegetation is an appropriation of certain substances or powers in the soil, the continued power of the soil depends on their decomposition on the spot, by which the same powers return into action in each following spring. But, in artificial cultivation, the products are usually carried away for the consumption and uses of the cultivators; and, hence, soils become weakened and exhausted for successive crops. To keep up the active powers of the soil, and yet carry off the crops for use, is, therefore, an object of great practical importance, and constitutes the study of rotation of different crops, and the most advantageous applications of such substances, or manures, as are found, by reason and experience, best to maintain fertility.

Manure, according to Davy, is carbonaceous matter, in such fine parts as enables it to enter the pores of the roots of plants. Whatever process, therefore, so prepares carbon is good as manure; and it may be presumed, that the exhaustion of soil means no more than that crops have exhausted the carbon in fine solution, and that a fresh supply is needed. The only use of fermentation appears to be the subdivision of the carbon in the vegetable fibres in the manure, so as to form soluble matter, and whatever subdivides it constitutes one of the ingredients of manure.

The most important and efficacious manure is pulverized bones, and all bony substances, as shells, &c. are equal or superior to farm-yard dung. Now it is curious that their chief constituent is lime; 100 parts of calcined bones being 81·9 phosphate of lime, 10 carbonate of lime, 3 fluate of lime, the remainder magnesia, soda, and carbonic acid; while shells consist of carbonate of lime and phosphate of lime. Then, the virtue of lime, as a manure, is well known by experience, and it would hence seem that the phosphate may be the best compound for this purpose.

Animal dung probably derives its efficacy from a variety of the same principle in its ammonia, and it seems likely that all other manures have more or less of the alkalinity of lime in them, as gypsum, soot, &c.

Sir John Sinclair considers bone manure as a discovery which distances all others in public value. It has been noticed for nearly 70 years by various writers, but not recognised as an established principle till 1828. About 20 bushels of pulverized bones are applied to the acre, and 30 and upwards, if not pulverized. They suit turnips, especially, and so strengthen the plant as to protect it from the fly.

Since sulphate of lime has this extraordinary quality in bones, it is worth while to observe that it is a very abundant substance as gypsum, plaster of Paris, selenite, and even alabaster. If these answer the purpose, it will be preferable to bones, the use of which is nauseating; and avarice has, it is said, led the Germans to discharge their ancient charnel-houses on ship-board. The Editor had a mill to grind gypsum, in 1791, but it did not decisively succeed, and well it might not, for only one or two bushels were applied on grass to an acre; and we now find that 20 bushels of bones are to be applied, and even 30 or 40.

In an estimate, Sir John Sinclair speaks even of 48 bushels to the acre, at 2*s.* 8*d.*; but we venture to say, that 30 bushels of gypsum and limestone, at 1*s.* would produce an equal effect, since it is all sulphate of lime and uncalcined bones contain, but 37·7 of phosphate of lime and 10 of carbonate of lime.

In truth, it is a circle of products and conversions, for limestone mountains are suspected to consist of shells, as carbonate, and, therefore, in lime, in gypsum, or in gross bones, we get the very same elementary principle. Perhaps lime, sulphate and carbonate, might be mixed in the bone proportions and applied. It is also curious that the weight of sulphuretted hydrogen 36, (used in making sulphate of lime) is exactly twice that of ammonia, 18; and there has been a prevalent idea which has referred the action of all manure to the "ammoniacal principle or salts."

On clay, as much as 600 bushels per acre have been laid of unslaked lime, and from 240 to 300 on strong lands; 150 to 200 are even laid on light soils. Now, if bone-dust is the test of perfection the above practice must be wrong, for bones contain no lime, and only the sulphate and carbonate. They are, however, half gelatine; but on all these subjects agricultural writers and practitioners commit error on error, by ignorance of chemistry.

It so happens, in contradistinction to Davy's doctrine of solubility, that sulphate of lime is so insoluble that it requires 500 parts of cold, and 450 of hot, water, to dissolve it; and, hence, it seems to act on a directly contrary principle.—*See* Lime.

To determine the manner in which gypsum contributes to vegetable growth, M. Peschier, of Geneva, has performed several comparative experiments. Two theories have been suggested, one, that the gypsum acts simply as a stimulus to the organs of the plant; the other, that it gives up to the plant its water of crystallization. M. Peschier filled two vessels with silecious sand, slightly moistened, and sowed in each of them a few seeds of water-cresses, and watered one of them with pure water, and the other with a solution of the sulphate of lime. The plants, when a few inches high, were burned, and equal quantities of their ashes were analysed. In those watered with the solution of sulphate of lime, there was found a much more considerable quantity of sulphate of potash than in the other. In a second experiment, he found that the proportion of sulphate of potash was increased when the plants watered with the solution of sulphate of lime were subjected to the action of a galvanic current. M. Peschier thence infers that the plaster undergoes a decomposition by the act of vegetation, and he has observed that crude gypsum is more efficacious than that which has been calcined.

In regard to dung-manure, spread over grass lands, Sir John Sinclair says it is, in general, manuring the atmosphere, and not the soil. Composts to the amount of 30 cubic yards per acre, or soot, ashes, lime, &c. are desirable, in dry weather, every fourth year. Scarifying, in some cases, rolling in others, is useful. No animal should be admitted in wet weather. In mere grazing-land, mole-hills and ant-hills are not considered disadvantageous; and some of the most profitable pastures in England are covered with them. Moss is got rid of by draining, and rich composts, with harrowing an inch or two deep. Mown grass land does not fatten cattle, and sown exhausts.

Meadows, exposed to irregular inundations, are of secondary value to what they would be if drained, embanked, and irrigated, at times when the stream is muddy.

Black or vegetable mould is the richest food for every species of crop.

Chalk strata may be manured either by the clay above it, or the black stratum beneath it.

Paring and burning the turf, on breaking up grass-lands, produces ashes valuable as manure. Wood-ashes, also, have the same effect.

*Salt Manure.*—In the experiments of Mr. Sinclair, at Woburn, the good effects of salt manure were striking. In one of his valuable experiments, an application of only 5¼ bushels of salt produced 91 bushels of wheat per acre; while, on the same soil, 45 tons of spit manure produced but 45 bushels of wheat. The use of salt, to prevent *smut* in wheat, by steeping the seed in its brine, is established. For barley, salt should not be applied in a larger proportion than 16 bushels per acre, nor in less than 10 bushels.

The following is a statement of the produce of garden crops manured with salt:—

*Windsor Beans.*

| | Produce in Bushels per Acre. |
|---|---|
| 1. Without any manure - - - - - | 135¼ |
| 2. Dressed with 20 bushels of salt per acre, a week before seed-time - - - - - | 217 |

*Onions.*

| | Tons. | cwt. | qrs. | lbs. |
|---|---|---|---|---|
| 1. Manured with 20 bushels of salt, and 10 tons of farm-yard manure - - - - | 3 | 12 | 3 | 12 |
| 2. With 12 tons yard-manure - - - - - | 2 | 10 | 2 | 19 |

*Carrots.*

| | Tons. | cwt. | qrs. | lbs. |
|---|---|---|---|---|
| 1. With 20 bushels of salt and 20 tons yard-manure | 23 | 8 | 1 | 18 |
| 2. With 20 tons yard-manure - - - | 22 | 18 | 0 | 26 |

*Early Potatoes.*

| | Bushels. |
|---|---|
| 1. Without any manure - - - - | 308 |
| 2. With 20 bushels of salt - - - - | 584 |

A general rule is, never to sow salt as a manure, with the seed. For potatoes, onions, carrots, and parsnips, from 10 to 12 cwt. per acre; laid on not nearer than one month *before* seed-time; and for garden-ground, in general, 14 or 16 cwt. per acre, to be laid on early in spring. Composts, 1 cwt. per load. Its principal use is, its property of absorbing moisture from the air, and retaining it in the soil; and, also, in destroying weeds.

Saltpetre is recommended as manure, and several instances are given in which it has been so applied with great and repeated success, especially in the cultivation of grass.

*Chimney soot.*—This article is said to be an excellent manure, if properly applied. It is generally mixed up with earth and dung as a compost; in this state it is worth little or nothing; but, when properly applied, by being kept dry, and sown on young wheat, clover or vetches, in March or April, its effects are most extraordinary; in a few days the yellow sickly plants will assume a dark-green.

All animal remains, ordure of all kinds, woollen rags, &c. &c. are excellent manures; and their virtue is ascribed to their ammonia. Sweepings of streets and roads are also useful.

The fact is, plants receive nearly as

much nourishment from the air as the roots: and, as the soot is throwing off abundance of gases, which are imbibed through the pores of the leaves, it gives a healthful vigour to the plant, and enables it to throw forth its roots to supply nourishment during the stages of blossoming and perfecting the seed.

The circle of nature is, first, the disintegration and pulverization of rocks into soil; second, the developement of vegetables, by the activity and decomposition of water and air, the decay of these, as food, and manure for future crops; and, third, the developement of insects and animals, the return of whose ordure and products, and, finally, of their bodies, is a debt to the soil which sustained them. This circle assures perpetual fertility, and it is only disturbed by man, who robs the soil, without making due returns, and often, in ignorance, errs in the nature of the returns. Nature animates every thing, and this universally affords manure; but man not only destroys all life except his own, but also deranges the vegetable products. To correct such practices constitutes the science of manures and restoration.

Since every operation of nature is carried on by correlative action, or by action and reaction, it may, perhaps, be generally inferred, that oxydation is the general tendency of soils; and that the application of alkalies, in ammonia, in lime, in soda of salt, &c. &c. in dilute forms, is the principle of all manures, and the cause of all growth, production, and fertility.

MAPLE, a genus of plants, consisting of trees or arborescent shrubs. Twenty-seven species are known, of which 12 inhabit North America, 6 are found in Europe, 6 in Japan, and the remainder in Asia.

The sugar-maple *(A. saccharinum)* is one of the most valuable. Besides the sugar which is obtained from the sap, the wood affords excellent fuel; and, from the ashes are procured four-fifths of the potash which forms such an important item of commerce. The sugar is superior, in quality, to the common brown sugar of the West Indies, and, when refined, equals the finest in beauty. A single tree of this species will yield 5 or 6 lbs. of sugar. It grows in cold and moist situations, between the 42d and 48th parallels.

*Sugar Maple*, *(acer saccharinum,)* *Sycamore*, and *Norway Maple.* — The sap of these trees, as well as that of the common maple, is used for making sugar and wine.

MARANTA INDICA, is the plant whose roots yield Indian arrow-root.

MARBLES FOR TOYS.—These well-known articles are made in great quantities, to serve in the games of children; some are formed of potter's clay, covered with a glaze, and burnt in a proper furnace; others are made of marble and alabaster, but chiefly of a species of very hard calcareous stone, found in the neighbourhood of Cobourg, in Saxony. These stones are first broken into square blocks by means of a hammer, and are finally rounded into spheres or small balls by a mill. In order to this, they are placed, from 100 to 150 at a time, upon a fixed slab of stone, having a number of concentric circular grooves or furrows made in its flat surface. Above this stone, another flat slab, or block of oak, of the same diameter, is supported by means of a lever, and turned round by the power of the mill. During the rotatory action of this mill, small threads of water are made to enter each of the concentric grooves, which favour the rounding and polishing of the balls, and prevent the wood from heating. The operation of each of the quantities above-mentioned lasts for a quarter of an hour, and the balls, or marbles, become perfectly spherical and fit for sale. Immense quantities of them are exported to India and China. A mill, with three turning-blocks, will manufacture 60,000 marbles a week.

MARIGOLD has flowers, which are cordial, hepatic, diaphoretic, and emmenagogue. — The *Wild Marigold* is cordial.

Marigold, French.—The dried juice is used in disorders of the eyes, and the flowers dye yellow.

Marigold, Marsh, is acrid and caustic, but externally useful in diseases of the reins or loins.

MARKING-INK for LINEN.—Take of iron-filings 1 lb., acetic acid, sp. gr. about 1·052, 2 lbs. Mix the iron-filings with half the vinegar; shake the mixture frequently, and, as it becomes thick, add the rest of the acetic acid, and of water 1 lb.

Heat the mixture, to favour the action of the acid upon the iron; and, when it is dissolved, add sulphate of iron 3 lbs., gum arabic 1 lb., previously dissolved in water 4 lbs. Mix them thoroughly while hot; these quantities usually give 12 lbs. of product. To employ it, the linen is stretched upon a table, and copper characters and a hair-brush are used.

MARLE, is compact limestone and argillaceous matter, and essentially composed of carbonate of lime and clay, in various proportions. Marl frequently contains sand and other foreign ingredients. It occurs in masses, either compact, or possessing a slaty structure. All solid marles crumble by exposure to the atmosphere, and it crumbles more easily, or forms a more tenacious paste, in proportion as it is more argillaceous. All marles effervesce with acids, sometimes very briskly and sometimes feebly, according to their solidity and the proportion of carbonate of lime, which may vary from 25 to 80 per cent. Earthy marle, like the indurated, may be either calcareous or argillaceous. It sometimes greatly resembles clay, but may be distinguished by its effervescence in acids. Marle is found associated with compact limestone, chalk, gypsum, or with sand or clay, and contains various organic remains, as shells, fish, bones of birds and of quadrupeds, and sometimes vegetables. Its most general use is as a manure, and whether a calcareous or an argillaceous marl will be more suitable to a given soil, may be determined by its tenacity or looseness, moisture or dryness.

*Loam* is sand and clay, *marl* is limestone and clay; and the more lime the better as manure, and the less the better for brick-making.

To analyse marle, or lias limestone; first pulverize and weigh it; pour diluted muriatic, or acetic acid on it, till effervescence ceases; wash it, and precipitate the solution by ammonia, and, as necessary, carbonate of ammonia; this will form carbonate of lime, which dry and weigh as the quantity or proportion in the marle.—*Farrady.*

MARLY, hydraulic machine at.—This machine, which is an inimitable but undesirable curiosity, raises 40,000 gallons of water per hour 533 feet high. The first stage is 160 feet high, the second 346, and the third 27 feet. The result is produced by the enormous number of 253 pumps. The expenses, when in work, were nearly 10*l.* per day, and the object is the supply of the Palace of Versailles, and its fountains.

MARSHALL'S CERATE, is made of 5 oz. of palm-oil, 1 oz. of calomel, nitrate of mercury 2 oz., and acetate of lead half a drachm.

MASTS.—In the British navy, in ships down to 60 guns, the main and foremasts have an inch in diameter for every yard in length. For 50 to 30 guns 27-28ths of an inch, and below 12-13ths. Top-masts 9-10ths of an inch per yard. The mizen-mast 15-22ds of an inch per yard. Bowsprit, 1½ inch per yard. Jibboom 7-8ths. The heighth of mainmasts in yards, is the breadth in feet, out and out, multiplied by 0·74 to 0·76 for various vessels. Then the fore-mast is the main-mast by 0·895 to 0·901. And the mizen is the main by 0·87 or 0·866. The bowsprit the main by 0·64 or 0·613. The main top, the main by 0·6 or 0·613. And the foretop, the main by 0·9, or 0·91.

In Indiamen, the main-mast is 80 feet long, 24½ inches in diameter, the topmast is 50 feet and 15 inches, and the top-gallant 28 feet and 8 inches. The fore-mast 72 feet and 24 inches, the mizen 70 feet and 17 inches, and the bow-sprit 50 feet and 25 inches in diameter.

Mr. Clink has invented masts which yield to the wind, and leave the vessel perfectly upright. This, of course, improves the sailing, and is attended by many conveniences as to crew and passengers, but is not adapted to vessels above 70 tons.

MATHEWS' AND STURKEY'S PILLS, consist of equal parts of black helabore, liquorice, and turmeric, and another part, purified opium, Castelle soap, and syrup of saffron, in pills with oil of turpentine.

MATHEWS' INJECTION FOR FISTULA, is diluted tincture of cantharides.

MATHIEU'S VERMIFUGE, for destroying tape-worms, consisted of 1 oz. of tin filings, 6 drs. of fern root, ½ an oz. of semina santonici, 1 dr. of resinous extract of jalap, same of sulphate of potass, and honey a sufficient quantity. A tea-spoon every three hours for two days. An electuary for expelling it was 2 scr. of powdered jalap, and sulp. of potash, 1 of scammony, and 10 grs. of gamboge, with honey.

MASTICH-TREE, (*pistachia lentiscus.*) Yields by incision mastich, its berries yield oil, and the wood is used in dyspeptic affections, gout, and dysentery.

MAXIMA AND MINIMA.—The investigation of the *maxima* and *minima* of quantities is the determining under what conditions a given variable quantity becomes greatest or least. Thus, to determine the *maxima* or *minima* of a curve, is to find such a value of the abscissa as corresponds to the greatest or least value of the ordinate, supposing the equation between the rectangular co-ordinates to be given.

RULE.—Differentiate the equation between $y$ and $x$, and put the first differential co-efficient, (that is, $\frac{dy}{dx}$), equal to 0; insert the value of $x$ thence found in the second differential co-efficient $\left(\frac{d^2y}{dx^2}\right)$ and if the result be *negative*, such value of $x$ before obtained corresponds to a *maximum* value of $y$; but, if the result be positive, to a *minimum*.

Example 1.—The equation to the ellipse, reckoned from the extremity of the *axis major*, is

$$y = \frac{b}{a}\sqrt{2\,ax - x^2}$$

$$\therefore \; dy = \frac{b}{a}\left(\frac{a-x}{\sqrt{2\,ax-x^2}}\right) dx$$

$$\therefore \; \frac{dy}{dx} = \frac{b}{a}\left(\frac{a-x}{\sqrt{2\,ax-x^2}}\right)$$

This, therefore, must be put $= 0$, *i. e.*

$$\frac{b}{a}\left(\frac{a-x}{\sqrt{2\,ax-x^2}}\right) = 0$$

*or*, $\quad a - x = 0$

$$\therefore \quad x = a$$

the meaning of which is, that when $x$ becomes $= a$, the ordinate $y$ is a *maximum* or *minimum*.

To ascertain whether such value of the abscissa corresponds to a *maximum* or *minimum*, we must differentiate again; thus, since

$$\frac{dy}{dx} = \frac{b}{a}\left(\frac{a-x}{\sqrt{2\,ax-x^2}}\right)$$

$$\therefore \; \frac{d^2y}{dx^2} = \frac{b}{a}\left\{\frac{-(2\,ax-x^2)-(ax)^2}{(2\,ax-x^2)^{\frac{3}{2}}}\right\}$$

in which, if we insert $a$ for $x$, being its value above found, the expression becomes

$$\frac{d^2y}{dx^2} = \frac{b}{a}\left\{\frac{-a^2}{a^3} = -\frac{b}{a^2}\right\}$$

which negative result proves that when $x = a$, the ordinate $y$ is a *maximum*.

Example 2.—Given $a$ and $b$ the adjacent sides of a parallelogram, it is required to determine when the area is a *maximum*.

Let $x =$ the angle of inclination of the sides $a$ and $b$, then the perpendicular $= b.\ \sin.\ x$ and if $y =$ the area

$$y = ab.\ \sin.\ x$$

$$\therefore \; dy = ab.\ \cos.\ x.\ dx$$

$$\therefore \; \frac{dy}{dx} = ab.\ \cos.\ x$$

consequently $\; ab.\ \cos.\ x = 0$

or $\; \cos.\ x = 0$

$$\therefore \; x = 90^{\circ}$$

or the sides must be at right angles.

Next, to find whether this value of $x$ corresponds to a *max.* or *min.*

$$\text{since } \frac{dy}{dx} = ab.\ \cos.\ x$$

$$\therefore \; \frac{d^2y}{dx^2} = -\ ab.\ \sin.\ x$$

in this expression let $x = 90^{\circ}$ and sin. $x = 1$, so that the result is negative, and the above value of $x$ denotes a *maximum* of the area.

*Note.*—If it happen that the value of $x$, obtained by making $\frac{dy}{dx} = 0$, also makes $\frac{d^2y}{dx^2} = 0$, it will be necessary to differentiate again, and put $\frac{d^3y}{dx^3} = 0$, inserting the resulting value in $\frac{d^4y}{dx^4}$ and so on.

If $x$ wholly vanish in differentiation, so that $\frac{dy}{dx}$ cannot be put $= 0$, or if, from any other circumstance, an impossibility arise, it follows that the variable quantity admits of no *maximum* or *minimum*.

The foregoing relates to the *maxima* and *minima* of quantities involving only *one variable*.

MEAD, is diluted honey, fermented, and conducted, like wine or beer, into a very wholesome beverage. But, in using honey, care should be taken that the producers were not destroyed.

MEAD'S POWDER *against the bite of a mad dog.*—Mix 1 oz. of black pepper with 2 oz. of burnt lichen.

MECHANICS (ANIMAL).—We have treatises on animal mechanics by writers, who, utterly ignorant of the source of animal power, refer it, with the monks of the dark ages, to miracle. In this respect they resemble Newton, La Place, &c. in their celestial mechanics; but, in the 19th century, it is proper to get rid of the mistakes of the 15th. An animal is such an organization as enables it, as to its own parts, to overcome the central force created by the twofold motions of the earth. Inert or dead matter is patient of the central forces; but every animal and vegetable derives, by its own organization, force enough from another source to counteract the central force, and displays this power in the heighth which it grows or rises perpendicularly, and in the breadth which it obtains at various angles. This source is the motions of the gaseous atoms, among, and in which, it exists, and which motions every animal appropriates, by its lungs and the reactions of the skin, with the consequent circulations, &c. The ordinary tendency of every atom in every animal and plant, as mere matter, is to obey the central force; but this tendency is corrected by organic functions, which continually derive from gas, by respiration, part of its independant lateral force. One acts in a line or axis, which equally divides the body; and the other acts in a series of deflections or radii from that line. The fulcrum of both, in general motions, is the point of contact with the ground; but the axis is a series of fulcrums for *local* or organic motions. All the muscular forces, in any general counteracting exertions, are, therefore, directed to the point of contact with the ground, as in walking, running, lifting, carrying, &c. but the hands, legs, &c. may locally move by muscular reactions of the two sides referred to the axis. The detail is what has been denominated animal mechanics and the phenomena of life.

MECHANICS, (PHYSICAL,) resolve themselves into arithmetic and geometry, because mere multiples of matter and motion in a vast variety of combinations. On these principles, all the phenomena of nature, and all the curious powers of machinery are framed and connected. All actual phenomena are matter and motion; the motions being derived from other motions often obvious, often latent; sometimes, a concentration of the minute, as in heat and gases, and sometimes deflections of great motions, too vast for vulgar observation. This is nature, and genuine philosophy; but there is a bastard, and specious scholastic philosophy, which sprang from ages of darkness and superstition, and which teaches a great variety of original powers, the offspring of human fancy, against which, honest enquirers after truth cannot be too vigilantly on their guard. It caricatures the majesty of nature; but, as caricatures are ingenious and amusing, so it seduces, and is very profitable. He, who would understand physical mechanics, must sedulously apply himself to arithmetic, geometry, the doctrine of ratios, drawing with scale and compasses, terrestrial and celestial mechanics, (as matter and motion,) and the various artifices of machinery.

MECONIC ACID, is made from opium. It turns the peroxide of iron red, and in this test is more useful than 40 of the 48 acids of chemistry.

MEDICINE.—Dr. Paris, in his admible *Pharmacologia*, divides medicines into simple powders, which require extreme pulverization, unless they contain a volatile or oxydizing principle, for which compound powders are preferable. Pills are another form, and their subtraction may be crumb of bread, starch, treacle, honey, or water. Electuaries formed with syrup, honey, treacle, or conserve. Mixtures and draughts, taking care that the fluids do not form new substances not extended. Clysters, or inhalations, and external applications, as embrocations, cataplasms, astringents, unguents, lotions, liniments, poultices, plasters, &c. Mineral acids do not yield, like vegetable ones, to the digestive process, but pass into the system as acids.

The medical sciences, or those connected with them, are the whole range of natural sciences, as zoology, (including comparative anatomy and physiology,) mineralogy, geology, botany, natural philosophy, chemistry, &c.: psychology, which teaches the various phenomena of nervous sensations: anatomy, which teaches the form and situation of the organs by the examination of dead bodies, and is divided into osteology, treating of the bones; syndesmology, of the ligaments; myology, of the muscles; splanchnology, of the intestines; angiology, of the vessels; neurology, of the nerves; and adenology, of the glands: organic physics, treating of the mechanical operations of the human body, the power, gravity, &c. of its parts: physiology, which treats of all the phenomena of life in connexion.

*Pathology*, on the other hand, is the science of disease, of that in which it consists, its origin, &c. *Nosology* treats of the various sorts of diseases, their origin and symptoms, and strives to arrange diseases into one whole. *Pathological anatomy* teaches the mechanical alterations and changes of structure. *Semiotics* teaches to infer, from the various symptoms, the nature of the disease; *diagnostics*, to distinguish the symptoms of different diseases; and *prognostics*, to infer, from the state of a disease, its future course.

*Therapeutics* is the science of the cure of diseases, often divided into *general*, treating of the subject of cure in general, its character, &c. and *special*, of the cures of the particular diseases. *Surgery* treats of mechanical injuries, and the mode of relieving diseases and derangements by mechanical means. *Obstetrics* treat of the modes of facilitating delivery. *Materia medica* is the science of medicines, their external appearance, history, and effects on the human organization. *Pharmacy* teaches how to preserve drugs, &c. and to mix medicines. *Clinics*, or medical practice, applies the results of all these sciences to real cases.

In the study of medicine, any popular journal gives the novelties of practice, and any good dictionary or practice of physic its established practices; but for original and well-digested principles, as a body of standard information, no work in the English language competes with the Encyclopedia of Practical Medicine, conducted by Drs. Forbes, Tweedie, and Conolly. It ought to be found in every medical collection, and even in every respectable library.

The same Editors, availing themselves of the popularity of the above-mentioned work, have announced a Body of Physiology and Anatomy, the precision and instruction of which will, no doubt, be equally valuable and beneficial. Theirs may be called the *British* school of medicine.

MEGILP, is the composition used by fancy painters for the ground in graining, or marbling. According to WHITTOCK, in his most excellent Painters' and Glaziers' Guide, it is best compounded of equal weights of sugar, of lead, and rotten-stone, ground stiff in linseed-oil; adding the same weight of turpentine to twice the weight of melted white wax, and when cold grinding the latter with the former. Keep it in a closed jar, and, when necessary, soften it for use with boiled oil. In graining, it is spread in limited spaces over the ground, and then tastefully wrought with various combs, till it represents the grain of natural wood. Mr. Whittock gives ample directions, accompanied by very tastefully-finished engravings for imitating oak, pollard, mahoganies, satin, walnut, rose, maples, coral, &c. woods; as well as nine kinds of marbles, and polished rocks. The manipulations are affairs of practice, care, and taste.

MENSURATION, is an application of arithmetic to dimensions and bulk.

Every superfices is the multiple of its length by its breadth, in equal denominations. To reduce the product of inches into feet, divide by 144 the inches in a square foot; or, if in feet by 9 for square yards; or, if in yards by 4840 for acres.

Every solid has three dimensions, length, breadth, and depth, and the multiple of these together is the cubic inches, feet, or yards, in whichever the dimensions are taken. Bring inches into feet, by dividing by 1728 the cubic inches in a cubic foot; or, feet into yards by dividing by 27, the cubic feet in a cubic yard.

When lengths or breadths are irregular, several should be taken, added together, and divided for a mean by the number; or, a figure may be reduced to two or more regular figures, and the dimensions of each added for the whole.

Very irregular figures are measured by immersing them in water in any regular vessel, and then determining the measure of the water which they displace.

In circles multiply the square of the diameter by 0·7854 for the area; or the square of the circumference by 0·07958. For a sector, the area is to the area of the whole circle as the degrees in the arc to 360. For a segment, deduct from the sector the area of the triangle formed by the chord and the radii.

For the solid contents of a sphere multiply the cube of the diameter by 0·5236. For the superfices of a sphere, multiply its circumference by its diameter. For the superfices of any zone, multiply the circumference of the whole sphere by the heighth.

The area of a circle, whose diameter is 1, is equal to a square whose side is 0.8862269.

The area of a square, whose sides are 1, are equal to a circle whose diameter is 1·1128379.

The radius of a circle is equal to an arc of 57·2957795 degrees.—*See* GUAGING, CIRCLE, ACRE, CHAIN, &c.

MENDEREUS, spirit of, see acetous acid, of which and ammonia it is formed.

MERCURY, OR QUICKSILVER, is found native, or as an amalgam with silver, or with sulphur, as cinnabar, which has two shades of red. Sometimes it is compact, or slaty, as a sulphuretted carbon, or corneous with chlorine. Little is obtained but from cinnabar, either opaque or massive, or transparent and crystallized. 150 lbs. yield 1 of mercury, by distilling it at a red heat for several hours. Its sp. gr. is 13·6 nearly. At 39° below zero, it is a concrete malleable metal. It is oxydized by the heat of 656°, and also by sulphuric, nitric acid, and chlorine. As a medicine it stimulates the glandular system, and thereby increases all the secretions. It is a very important specific in syphilis. Its preparations are at least thirty in number, and their effects are a leading part of medical science. It is chiefly used as calomel, or as a liniment, and calomel is a sublimation or precipitate by combination with chlorine or oxymuriatic gas.

It was the *hydrargyrum* of the Latins, and the name *quicksilver* is derived from the alchemists, who regarded this metal as silver in a fluid state, quickened by some inherent principle, which they hoped either to fix or expel.

It is distinguished from all other metals by its extreme fusibility, which is such that it does not take the solid state until cooled to the 39° below 0, and, of course, is always fluid in the temperate climates of the earth. Its colour is white, and rather bluer than that of silver. In the solid state, it is imperfectly malleable.

At 600°, it boils rapidly, and rises copiously in fumes. When exposed to such a heat as causes it to rise quickly in the vaporous form, it gradually becomes converted into a red oxide. This was formerly known by the name of *precipitate per se*. A greater heat than 656°, however, revives this metallic oxide, and oxygen is again liberated.

Its black protoxide is 2 mercury, and 1 oxygen; and its red binoxide 1 mercury, and 1 oxygen.

The *phosphuret* is formed by heating either of the oxides along with phosphorus, in a retort filled with hydrogen gas, or under water, with frequent agitation: the oxide is reduced, and a phosphuret is the result. It is of a black colour, is easily cut with a knife, and, in the air, exhales vapours of phosphorus.

There are two sulphurets, the black and the red, or the *proto-sulphuret*, and the *deuto-sulphuret*. The first is formed by rubbing vigorously in a glass or porcelain mortar three parts of sulphur and one of mercury, or by adding mercury at intervals, and with agitation, to its own weight of melted sulphur. The second, which is commonly called *cinnabar*, or *vermilion*, is formed by subliming the proto-sulphuret. The process consists in grinding together 150 lbs. of sulphur and 1080 of quicksilver, and then heating the mixture in a cast-iron pot, two and a half feet in diameter and one foot deep, precautions being taken that the mixture does not take fire. The calcined Ethiops is then ground to powder, and introduced into pots capable of holding twenty-four oz. of water each, to which are attached subliming vessels, or bolt heads of earthenware. The sublimation usually takes thirty-six hours, when the sublimers are taken out of the furnace, cooled, and broken.

The *proto-chloride* of mercury (*mercurius dulcis*, or *calomel*), is usually formed from the deuto-chloride, by triturating four parts of the latter with three of quicksilver till the globules disappear, and subjecting the mixture to a subliming heat. The following is the process used at Apothecaries' Hall:—50 lbs. of mercury are boiled with 70 lbs. of sulphuric acid to dryness, in a cast-iron vessel; 62 lbs. of the dry salt are triturated with 40½ lbs. of mercury until the globules disappear, and 34 lbs. of common salt are then added. This mixture is submitted to heat in earthen vessels, and from 95 to 100 lbs. of calomel are the result. It is washed in large quantities of distilled water, after having been ground to a fine and impalpable powder.

Nitric acid dissolves, converting it into corrosive sublimate.

A *fulminating* preparation of mercury is obtained by dissolving 100 grs. in 1¼ oz. by measure of nitric acid. This solution is poured cold into 2 oz. by measure of alcohol in a glass vessel, and heat is applied till effervescence is excited, though it ordinarily comes on at common temperatures. A white vapour undulates on the surface, and a powder is gradually precipitated, which is immediately to be collected on a filter, well washed, and cautiously dried. This powder detonates loudly by gentle heat or friction. It is used as the match-powder, or priming, for the percussion caps of detonating locks. Two grains and a half of it, mixed with one-sixth of that weight of gunpowder, form the quantity for one percussion cap.

Mercury dissolves all the metals except iron, forming amalgams with them. With arsenic and antimony by heat.

Mercury may be cleansed by forcing it through chamois leather, hazel wood, or a cone of fine paper. Sometimes it is shaken in a bottle with powdered loaf-sugar, and then passed through a paper funnel. If mixed with other metals, it should be distilled.

When mercury falls round a glass vessel, instead of rising like water around the vessel, it is the glass, as the lighter vessel, that rises as to the mercury, in reaction against the air. When mercury, in rising, falls round a barometer tube, and is convex, it is owing to the friction of the glass being greater than that of the particles of the mercury in the centre. On these trifles much execrable nonsense has been published by the scholastic mathematicians.

*Mercurial ointment* is its most efficacious exhibition, and that prescribed by the colleges contains from 30 to 12 grs. in a dr.; but Donovan has made an ointment of equal efficacy by chemical combination, every dr. of which contains but 2½ grs. of mercury.

It is also made of equal parts of mercury and suet with 3 of hog's lard, well triturated in a mortar. A dr. is rubbed inside the thighs by persons with whom mercury does not agree in the stomach.

*Mercurial pill.*—Mix well 5 drs. of mercury with 2 drs. of Strasburgh turpentine, and add 1 dr. of rhubarb and 3 scr. of extract of cassia.

MERCURIFICATION, is an alchemical operation, by which metals are said to be reduced into a fluid, heavy, opake, and shining liquor, like ordinary mercury: or, by which the mercurial principle may be extracted from metals, and obtained in the form of quicksilver.

If cinnabar of antimony made with corrosive sublimate be distilled, we shall obtain, by reviving the mercury, a larger quantity of mercury than was originally in the corrosive sublimate.

If a corrosive sublimate be prepared with muriatic acid and fluid mercury, and if oxide or filings of silver be several times sublimed together with this corrosive sublimate, a part of the silver will be changed into mercury.

Very fine filings of iron, exposed during a year to the air, and afterward well triturated in a mortar, and cleansed from dust and extraneous matter, then exposed during another year to the air, and, lastly, distilled in a retort, furnish a hard matter, which attaches itself to the neck of the retort, and with this matter a little mercury.

If oxide of copper be mixed with sal ammoniac, and this mixture exposed during a certain time to air, and distilled with soap, mercury will be obtained.

If luna cornea, or plumbum corneum, be mixed with an equal weight of very concentrated muriatic acid, digested together during three or four weeks, then an equal quantity of black flux and Venice soap added to it, and the whole matter distilled in a glass retort, some mercury will pass into the receiver.

METALS.—In considering metals as usually presented to us, they are not in that state to be regarded as natural, but as artificial products. In enquiring into their origin, we have to consider the manipulations of art, which, by fire and decomposition, has brought to that form the compound ores which constituted their original state. They are usually found in veins, fissures, and spaces formed by different kinds of rocks near or remote; and the differences of such rocks, in conducting heat and chemical action, seem necessarily to generate an electrical action and reaction, which is to be regarded in all cases as the mere play of oxygen and nitrogen, disturbed by different surfaces. These carrying from surface to surface the fine particles of the rock, in time extended to many thousands of years, would fill the intermediate space with compounds of oxygen, nitrogen, and the aura or fine matter of the rocks, on whose difference, inherent and combined, would depend the character of the resulting ore, its matrix, &c. Such, at least, is the general principle, confirmed by the confusion of rocks in all metallic districts, and by our better and improved knowledge of the nature of electrical action. That ores grow, is fully believed by all miners; and, there are many conclusive facts in proof. That they grow in the manner described, cannot now be reasonably doubted. We then drive off the oxygen and the heterogeneous bodies, and melting the nitrogen and rocky matter, produce our purified and artificial metals. These we find more or less disposed, in air, to return to the state of ore by abstracting the oxygen, and, as in other cases, arising from variety of constituents, we have every degree of this tendency, from the evanescent potassium, to the fixed character of gold and platinum.

Every phenomenon affirms this electrical theory of the generation of ores. The matrix of finer grain than the adjacent rocks, with similitude of crystallization, and every indication of simultaneous generation, are certain decrees of proof. The presence of arsenic is a problem to be solved, but that of sulphur accords with the fact, that a stroke of lightning almost suffocates the inmates of a struck building with the effluvium of sulphur. Attention to the subject cannot but bring hundreds of collateral proofs, and, in due time, connection will be traced between the rocks, the matrix, the mineralizers, and the metal produced. The silent action of undisturbed galvanism for a thousand centuries could not fail to produce intermediate substances, and those are the fine matrix, the sulphur and arsenic and our metallic particles. The whole are the chemical products of the principles of acidity and alkalinity acting on the rocks, in combination with atmospheric air, and excited by the constant pressure of that active central force, which is unceasingly produced by the two-fold motions of the planet.

Mr. Robert Ware Fox has published decisive evidence of considerable electrical action in the mine of Huel Servel, in Cornwall. His apparatus consisted of small plates of sheet copper, nailed, or else wedged closely, against the wooden props stretched across the galleries. Between two of these plates of different stations a communication was made, by means of copper wire, one twentieth of an inch in diameter, which included a galvanometer in its circuit. In some instances, 300 fathoms of copper wire were employed. The intensity of the electric currents was found to differ considerably in different places; it was generally greater in proportion to the greater abundance of copper ore in the veins; and, in some degree, also, to the depth of the station. His experiments enabled him to give a table of the relative powers of conducting galvanic electricity possessed by various metalliferous minerals.

Of course, as Mr. Fox was in possession of no rational theory of electricity, his industry would be misdirected; and his observations are merely useful, as proving the existence of such an action among the rocks of mines.

Arguing from the phenomena of potassium, sodium, barium, &c. metals are alkalies, combined with sufficient oxygen to prevent their becoming oxides in the ordinary state of the atmosphere, though nearly all have this tendency. Potash, &c. are the oxides of potassium, &c. and are reduced from oxides to metals, by expelling the oxygen, with the atomic force and double action of galvanic poles. The oxygen combined does not, however, neutralize the alkaline base, but is merely sufficient to protect it against the ordinary atmosphere. Now, other metals, in various degrees, seem to contain the sufficiency of oxygen, but it is obvious, that all of them equally consist of oxygen and an alkaline base; whether the alkaline base is simple or compounded does not appear, though the varied colours and reactive powers of different metals imply some combination with the alkali.

The specific characters of minerals are three. Specific gravity, hardness, and crystalline form, which last is either rhombohedral, pyramidal, prismatic, or tessular; *i. e.* hexagonal. A collection of similar species are a genus, of generas an order, and of orders a class.

There are seven metals with proven alkaline bases; potassium, sodium, barium, strontium, calcium, magnesium, and lithium.

There are six with earthy bases; aluminum, glucinum, cerium, yttrium, zirconium, and thorcium; *i. e.* formed by reducing the earths to metals by abstracting oxygen from the earths, which seems probably to be a compound of carbon with other elements. When these metals are oxidized, the products are white powders, without flavour.

Oxides of iron, nickel, cobalt, and manganese, are irreducible in fire, but dissolve in acids.

Oxides of gold, platinum, and four others, are reduced to the metallic state by heat alone, and they require great heat to oxydate them.

Metals, in general, seek to return to their original state as oxides, with two or three exceptions of the harder kinds, arising apparently from the excess of a silicious or quartz base over the alkali, combined during their electrical generation.

The most *ductile* and *malleable* of the metals, in order, are cadmium, copper, gold, iridium, iron, lead, &c.; and tin and zinc the least.

The most brittle are, antimony, arsenic, bismuth; and tunstein, titanium, and uranium the least.

The most facile for wire poles, in order, are gold, silver, platinum, iron, copper, zinc, tin, lead, and nickel.

The easiest made into plates, or sheets, by rollers, in order, are gold, silver, copper, tin, platinum, zinc, iron, and nickel.

When metals require to be *granulated* for manufacturing purposes, they are poured into water, or briskly agitated in a box while congealing, by which they fall into powder instead of crystallizing. A cullender, or ladle with holes, is used in dropping into water.

Silver may be reduced to fine grains by first dissolving it in nitric acid, and then immersing a plate of copper, to which the silver will attach itself; but it must be shaken off till the greater part of the silver has settled at the bottom, when the copper and solution may be taken away, and the precipitate washed and dried.

Copper may be obtained in grains in like manner, by immersing a plate of iron in a solution of the copper and sulphuric acid. When the iron plate is put in, a little more sulphuric acid should be added, and the copper will fall to the bottom, after which, it should be washed with dilute sulphuric acid, and with water, and dried.

To obtain gold in powder, dissolve it in muriatic acid, and then add protosulphate of iron. The gold will be precipitated, and then it should be washed with some muriatic acid, and with water and dried.

Platina may be had in fine powder, by dissolving it in ammonia-muriate, and heating it in a crucible to redness, till no more fumes arise. It then resembles sponge.

Zinc is reducible to fine powder when hot, if pounded by a heated iron mortar in a heated pestle.

When platina is alloyed with other metals, it becomes soluble with them.

Besides the *alloys* enumerated at alloys, steel 500, and silver 1, produce a fine cutting metal.

Steel, too, alloys with rhodium, in razors made at Sheffield; and with gold and nickel, also with platinum, in the proportion 1 platinum, 8 steel, with the finish polish.

All the nitrates are soluble. The muriates generally. The sulphates are insoluble, except by solutions of barytic salts. The acetates are soluble. The alkaline earths are soluble in solutions of sugar. Tartrates render many metallic oxides soluble.

Dr. Thomson divides metals into four clases. 1. *Malleable metals.* Platina, gold, silver, nickel, mercury, palladium, rhodium, iridium, osmium, copper, iron, tin, lead, and zinc. 2. *Brittle and easily fused.* Bismuth, antimony, tellurium, and arsenic. 3. *Brittle and difficult of fusion.* Cobalt, manganese, chrome, molybdena, uranium, tungsten, and titanium. 4. *Refractory*, or such as have never yet been reduced. Columbium, tantalium, and cerium.

Metals, like other fusible bodies, have each a fixed temperature, or freezing point, at which they become solid. The specific gravity is considerably affected by the gradual or hasty cooling, or transition from the fluid to the solid state. Hammering renders them harder and more elastic; but this effect is destroyed by ignition.

Mountainous districts, where the surface of the globe has been thrown up or disturbed, in remote ages, by earthquakes, volcanoes, or other great convulsions of nature, are the most abundant in metallic bodies. In digging into the bowels of the earth, the various metals are mostly found disposed in strata or beds, which in plains lie level, but in mountains are inclined; whence it happens, that in mountainous countries some strata are often exposed to the day, which would else have been too deeply lodged to be come at by human art. It is in the stratified mountains that metals are usually found, mostly in a state of combination either with sulphur or arsenic, or in the state of an oxide.

Iron ore sometimes forms entire mountains; but, in general, the metallic part of a mountain is very inconsiderable in proportion to the whole. The ores run either parallel to the stony strata, though far from having the same regularity of thickness, or they cross the strata in all directions. These metallic stata are called veins. The cavity formed by art in the earth, for the extraction of metals or any other mineral bodies, is called a mine. The stone, wherein a metallic ore is usually bedded, is called its matrix.

Metallic substances are said to be mineralized, when deprived of their usual properties by combination with some other substance The commonest mineralizers are sulphur, arsenic, and carbonic acid. Oxygen is as common as any, but is not usually reckoned among mineralizers.

METALLIC POISONS.—There is a simple electro-chemical method of ascertaining the presence of different metals; applied to detect minute quantities of metallic poisons. It consists of small slips of different metals, generally zinc and platina, placed in contact, and forming a galvanic circuit with the interposed fluid suspected to contain the poisonous metal: in which case, the metal held in solution is deposited in the form of crystals, on the negative surface. The zinc is usually employed in the form of foil; the platina is, in some cases, a small crucible, or a spatula, but more frequently platina foil is used. It is generally necessary to mix a few drops of acid with the metallic compounds that are subjected to this test, and that are placed in contact with the platina; on applying the zinc foil, the platina will soon become coated with the reduced metal. Dr. Davy was enabled to detect the presence of arsenic, by the exhibition of its characteristic properties, when only the 500th part of a grain of that metal was deposited on the platina; and, in some instances, could appreciate even the 2500th part of a grain, by the application of appropriate tests. The presence of arsenic is readily discovered when mixed with all the ordinary articles of diet; also when mixed with the secretions of the alimentary canal, as bile and saliva. Arsenious acid mixed with butter, lard, and oils, or with sheep's blood, or ox bile, is detected with great ease, and similar results are afforded by corrosive sublimate, the acetate of lead, and sulphate of copper, added in small quantity to the most complicated mixtures.

METONIC CYCLE, is the time, 19 years, or 6939·75 days, in which the new and full moons recur on the same days of the year. 19 years × 365·24224 is equal to 6939·60156 days; and 235 moons × 29·5305887 days, is equal to 6939·68834 days. The true solar year is 365 days, 5 hours, 48 minutes, and 49·62 seconds. The time between full moon and full moon is 29 days, 12 hours, 44 minutes, 2·8 seconds.

MEZERION *(Daphne)*, as cultivated, is a powerful medicine, acting as a diaphoretic, in doses 1 to 10 grs., and also as a valuable substitute, in many cases, for blisters and serous discharges, in which it relieves scrofula, rheumatism, &c.

MICROCOSMIC SALT, or fusible salt of urine, is made by dissolving 16 parts of sal ammoniac in a very small quantity of boiling water, adding 100 parts of crystallized phosphate of soda, filtering the solution, and letting it cool slowly, when small crystals are formed. If not pure, it melts into an opake globule, and must then be redissolved and recrystallized.

MICROSCOPES, are combinations of lenses, for viewing the image which the convex object-glass presents at the focus. The object-glass is a mere infinite-sided multiplying-glass, which concentrates every point of the object in the focus with diverging rays. The eyeglass converts the diverging into parallel rays, and enables the eye to view the image in the focus very near. The principles on which the reflecting and achromatic telescope are constructed, have been recently applied with success to the microscope, and have added much to the power of that instrument. Tulley's compound achromatic microscope consists of a combination of object-glasses, of short focus and large aperture, the curvatures of which are such as very nearly to equalize the refractions produced by each.

The magnifying power may be varied at pleasure, either by drawing out the tubes containing the eye-pieces, or by substituting an eye-glass of different power or differently combined; and by these changes an uninterrupted range of amplification is obtained from thirty-five to 800 diameters of the objects. No sensible loss as to distinctness is observable, whether the effect is produced by changing the eye-piece, or by varying the length of the tubes.

When a pencil of rays proceeding from an indefinitely small bright portion of an object is brought to a focus, by the most perfect object-glass, the image thus formed is in reality not a point, but a small circle, and will always appear as such, if the eye-glass of the microscope be sufficiently powerful. These circles have a considerable analogy to the spacious discs of stars viewed through telescopes. Like the latter, they become much enlarged by diminishing the aperture of the object-glass; and they are also enlarged by increasing the intensity of the illumination. The overlapping of contiguous circles of diffusion has given rise to many fallacious appearances, such as the spottiness which some surfaces assume, and which have been mistaken for globules. This optical illusion, says Lister, has been the basis of some ingenious but visionary speculations on the intimate structure of organic matter. The appearance, in certain directions of the light, of lines on the surface of an object where they do not really exist, may be traced to a similar cause.

These circles, in truth, arise from the irregular refractions, easily understood by considering all magnifying merely as the effect of a multiplying-glass, and that glass with an infinite number of sides, as in true convexity.

The circumstance which limits the magnitude of the pencil, admissible with high powers by a single achromatic object-glass, is, that the correction for spherical aberration, by the concave lens, is proportionably greater for the rays that are remote from the centre, than for the central rays. The degree of confusion in the image hence arising is, in similar glasses, inversely as the square of their focal lengths.

The *Solar microscope*, once so important, is now superseded by the light from a pea of lime ignited by the *oxy-hydrogen blow-pipe*. A stream of oxygen gas, and another of hydrogen gas, brought into union, and projected in an ignited state upon a mass of lime, produce a light of intense brilliancy, which passing through a lens, throws the images of objects magnified from 10,000 to 500,000 times, in the manner of a solar microscope, upon a disk of 14 feet diameter. Carey, and others, use it with effect, in very useful popular exhibitions.

*Microscope of Diamond.*—Mr. Pritchard, of Picket-street, has succeeded in forming a very thin double convex lens, of equal radii, and about 1-25th inch focus, from a very perfect stone of the finest water. Its polish is very beautiful, and the large angle of aperture which it bears attests the slightness of its spherical and chromatic aberration. It appears, from Mr. P.'s experiment, that, though the refractive power of different stones varies considerably, if a diamond and a piece of plate-glass are ground in tools of the same figure and radius, the magnifying power of the former will surpass that of the latter as eight to three; so that, if the power of the glass microscope should be 24, that of the diamond will be 64.

A very convenient extemporaneous microscope may be made by pricking a fine hole in a card, or piece of stiff paper. The narrow pencil of rays is manageable by the front of the eye, and objects may be distinctly seen at half an inch, consequently with linear increase of 16, and superfices of 256. At three or four inches, such a hole will supply the place of spectacles, in reading, &c.

MILLS are, in the original sense, establishments for grinding grain, &c., but the word is often synonimous with factory or manufactory, and applied to any thing wrought by machinery.

*Flour Mills* have, for ages, been wrought by water and wind, but latterly steam has been applied. The principle is the same in all, the rotation of a stone in juxtaposition with a fixed one, with hopper for supply, and bolter for sifting. Doubts being entertained of the integrity of many millers, various mills for domestic grinding have been invented, as Stockdale's and Rustall's, with detached bolters. Rustall's consists of vertical stones of 30 inches, one of which is turned by a winch, and altogether most complete, and his bolter is equally excellent. It has been adopted in prisons, workhouses, barracks, and other establishments.

The grain falls from the hopper into the eye of the upper mill-stone, and by its revolution is passed between the stones, and thrown out, as flour, meal, or malt. The number of revolutions in a minute ought to be 450, divided by the diameter in feet.

An upper stone, of six feet, contains about $22\frac{1}{2}$ cubic feet, at 840 or 850 lbs. to the foot, and its revolutions about 75 per minute. The water-wheel may be 18 feet, if the floats move with a third of the velocity of the stream.

A sack of wheat per hour may be ground with a power able to raise 900 lbs. 70 feet per minute; for 2, 3, or 4 sacks, the power rises in less ratio than the multiple, *i. e.* 2100 lbs. at 70 feet, would grind 3 sacks of rye or wheat.

To grind 3 sacks per hour requires a cylinder of a steam-engine of 20 inches, and 1 sack a cylinder of 12·5 inches. To do the same work, 3 and 1 sack, with an overshot water-wheel of 12 feet, requires 1600 and 660 imperial gallons of water; with a wheel of 16 feet, 1200 and 500 imperial gallons; or with a wheel of 24 feet 800 gallons and 330 per minute.

In a corn-mill, there are three departments. 1. The revolving sieve and fan, to clean the corn before it descends to the hopper. 2. The hopper and the stones. 3. The cooler and vibrating bolter, where it is dressed. A system of buckets raises the grain to the sieve, and the flour to the bolter, by various applications of the moving power.

Bigelow proposes to make holes in the cap or running-wheel, to prevent the heating and clogging of the meal, in cases of increased velocity.

Mill-stones are hard grit or granite-stones, cut into grooves in octagonal sections, so as to cross each other in working, and make the grain pass over the largest surface. Eight radii, at 45°, are first grooved with a double hammer, pick, and chisel, and then six other roads or grooves are chisselled and picked parallel to each of these radii; the stones then work parallel. Some work right-handed, others left-handed, but the grooves must tally.

*Flax Mills* are water-mills, which turn rollers for bruising the rough flax, and revolving or turning spikes or scutchers to clear the flax presented to them. Forty aws for the water-wheel, and 102 cogs for the power, moving another with 25 teeth for the middle roller, are the proportions of Gray.

*Flatting Mills*, for reducing metal to plates, are rollers turned by horses, or steam-power, through which the metal is passed and repassed. The distances of the rollers are adjusted by screws, turned by pinions. Lead, copper, and silver are rolled thus, and copper is silvered by rolling a thin plate of silver fixed to a thick one of copper, and, by repeatedly passing through the rollers, constantly narrower or closer, a perfect thin sheet of silvered copper is produced which may be cut or stamped for plated ware, or other purposes.

A *Sugar Mill* is formed by three upright rollers, the one moving, and the side ones fixed, or sometimes the three moving. The rollers are turned by mules, water, or steam-power, and the canes are placed between the rollers by hand. The expressed juice runs into a trough, and thence into a reservoir.

In an *undershot* water-wheel, the *quantity* is the velocity in a second into the area of the water-way. And the *power* is the quantity into the weight of a cubic inch of water, and the velocity. The power is to the effect produced, as 10 to 3·62.—*Smeaton.*

In an *overshot* wheel, the power is the product of the descent from the head to the bottom, and the weight of the water expended in a second. The power is to the effect as 10 to 6 6.

The velocity at a maximum load is three feet in a second.—*Brunton.*

The velocity is the square root of the space fallen through. For the same stream, falling, turns a wheel 57 times in a minute, and directed to the centre as in an undershot wheel, turns it but 38·5 times, which are as 1 to 1·414, the square root of 1 and 2 nearly.—*Banks.*

Therefore, the velocities will be as the square roots of their diameters, in all overshot wheels.

*Portable Horse Mills.*—The horse is attached to the extremity of a cast-iron lever, which puts in motion a large horizontal wheel, the upright axis of which is sunk into the earth, and having a groove around its rim, which is armed with points of iron; these points enter the links of a chain, which passes around the great wheel, and through two cast-iron trunks, or tubes, which are buried in the earth, under the horse-walk. This chain very conveniently communicates the motion to any distance, and in any direction required; and either of each may be varied *ad infinitum*, without much loss of time, or the employment of any considerable quantity of materials. Two men only were able to re-establish a mill in the course of an hour, in a fresh situation in the open air. The horse is attached to the outer end of the lever, by means of a swingle-tree and traces, which should be as short as possible.

MILKING.—By the more scientific plan of milking, instead of drawing down or stripping the teat between the thumb and fingers, the dairy-maid follows more closely the principles which instinct has taught the calf. She first takes a slight hold of the teat with her hand, by which she merely encircles it; then lifts her hand up, so as to press the body of the udder upwards, by which the milk escapes into the teat; or if (as is generally the case when some hours have elapsed between milking times) the teat is full, she grasps the teat close to its origin with her thumb and fore-finger, so as to prevent the milk which is in the teat from escaping upwards; then making the rest of the fingers to close from above downwards in succession, forces out what milk may be contained in the teat through the opening of it. The hand is again pressed up and closed as before, and thus, by repeating this action, the udder is completely emptied, without that coarse tugging and tearing of the teat, which is so apt to produce disease.

The principles of milk appear to be united together partly in a chemical, and partly in a mechanical manner; and the butter seems to rise to the top, in consequence of the greater specific gravity of the whey, through which it is dispersed. Cream consists of butter mixed with much whey and curd. It is generally thought that the separation of the butter, by churning, is effected simply by the agitation, which causes the fatty particles to strike against each other, and coagulate into larger masses.

M. Dirchoff, the Russian chemist, has found a mode of keeping milk for use for any definite space of time. He causes new milk to be evaporated over a slow fire, until it is reduced to a powder. This powder is then put into a bottle, which is hermetically sealed. When the milk is wanted for use, it is only to dissolve some of the powder in a reasonable quantity of water, and the mixture so dissolved will have all the qualities, as well as the taste of milk.

*To prevent Milk turning Sour, and Curdling.*—The milkmen of Paris add a small quantity of sub-carbonate of potash or soda, which, saturating the acetic acid as it forms, prevents the coagulation or separation of curd; and some of them practise this with so much success as to gain the reputation of selling milk that never turns. Often, when coagulation has taken place, they restore the fluidity by a greater or less addition of one or the other of the fixed alkalies. The acetate which it thus formed has no injurious effects.

*Cow's Milk*, boiled with sugar, will keep some time; and a little calcined magnesia will also prevent its turning sour, even in hot summers. *Skimmed milk* sits more easy on the stomach, and is used as a varnish, and vehicle for painting in distemper.

*Frangipane* is skimmed milk, evaporated to dryness, by a gentle heat, and used to form artificial milk.

*Scotch Sour Cream.*—At night, put skimmed milk into a wooden tub, with a spigot, which put into another, and fill the latter with hot water; in the morning take out the small tub, and draw off the thin milk, *wigg*, until the thick sour cream begins to come. This process requires practice, properly to heat the water, and, when it succeeds, skimmed milk yields nearly one-half of this cream, which is eaten with sugar, as a delicacy; only distinguishable from cream by its taste, and sells at double the price of fresh milk.

MINERALS comprehend all the solid matters of the earth, not vegetable or animal: for, though these last are in substance mineral, yet their organization and phenomena separate them from the simple mineral. In like manner, though the gases and acids may be generated from minerals, and, again perhaps concentrated into minerals, yet they are not in a just sense to be regarded as minerals.

The system of Mohs includes these as two genera, and adds a third in water. Logic thus confounds nature. As a summary, we will subjoin his orders strictly mineral, as a brief exhibition of similar substances.

*Salt Order.*—GENERA. 1. Natron. 2. Glauber. 3. Nitre. 4. Rock. 5. Ammoniac. 6. Vitriol. 7. Epsom. 8. Alum. 9. Borax. 10. Brythine.

*Haloide Order.*—GENERA. 1. Gypsum. 2. Cryone. 3. Alum. 4. Fluor. 5. Calc.

*Baryte Order.*—GENERA. 1. Parachrose. 2. Zinc. 3. Scheelium. 4. Hal. 5. Lead.

*Malachite Order.*—GENERA. 1. Staphyline. 2. Lirocone. 3. Olive. 4. Azure. 5. Emerald. 6. Habroneme.

*Mica Order.*—GENERA. 1. Euchlore. 2. Cobalt. 3. Iron. 4. Graphite. 5. Talc. 6. Pearl.

*Spar Order.*—GENERA. 1. Schiller. 2. Disthene. 3. Triphane. 4. Dystome. 5. Kouphone. 6. Petaline. 7. Feldspar. 8. Augite. 9. Azure.

*Gem Order.*—GENERA. 1. Andalusite. 2. Corundum. 3. Diamond. 4. Topaz. 5. Emerald. 6. Quartz. 7. Aximite. 8. Chrysolite. 9. Boracite. 10. Tourmaline. 11. Garnet. 12. Zircon. 13. Gadolinite.

*Ore Order.*—GENERA. 1. Titanium. 2. Zinc. 3. Copper. 4. Tin. 5. Scheelium. 6. Tantalum. 7. Uranium. 8. Cerium. 9. Chrome. 10. Iron. 11. Manganese.

*Metal Order.*—GENERA. 1. Arsenic. 2. Tellurium. 3. Antimony. 4. Bismuth. 5. Mercury. 6. Silver. 7. Gold. 8. Platina. 9. Iron. 10. Copper.

*Pyrites Order.*—GENERA. 1. Nickel. 2. Arsenic. 3. Cobalt. 4. Iron. 5. Copper.

*Glance Order.*—GENERA. 1. Copper. 2. Silver. 3. Lead. 4. Tellurium. 5. Molybdenum. 6. Bismuth. 7. Antimony. 8. Melane.

*Blende Order.*—GENERA. 1. Glance. 2. Garnet. 3. Purple. 4. Ruby.

He then makes *sulphur*, *resin*, and *mineral coal* separate orders.

HARDNESS in minerals is expressed by the figures 1 to 10, with the letter H.

1 is as Talc.
2 .. Gypsum.
3 .. Calcareous Spar.
4 .. Fluor Spar.
5 .. Apatite.
6 .. Feldspar.
7 .. Quartz.
8 .. Topaz.
9 .. Corundun.
10 .. Diamond.

MINERAL WATERS, are those waters which contain such a proportion of foreign matter as to render them unfit for common use, and give them a sensible flavour and a specific action upon the animal economy. They are commonly divided into four classes: acidulous, or carbonated, saline, chalybeate, or ferruginous, and sulphureous. In regard to temperature, they are also divided into warm, or thermal, and cold. The substances which have been found in mineral waters are extremely numerous, but those which most frequently occur are oxygen, nitrogen, carbon and sulphur, in different combinations; lime, iron, magnesia, &c.

The *saline* springs consist, in general, of salts of soda and lime, or of magnesia and lime, with carbonic acid, and oxide of iron. The principal are those of Pyrmont, Sedlitz, Epsom, &c.

The *ferruginous* waters have a decided styptic taste, and are turned black by an infusion of gall-nuts. The iron is sometimes in the state of an oxide, held in solution by carbonic acid; sometimes exists as a sulphate, and sometimes both as a sulphate and carbonate. The waters of Vichy, Spa, Forges, Passy, Cheltenham, Tunbridge, Bedford, &c. are among them.

The *acidulous* waters are characterized by an acid taste, and by the disengagement of fixed air. They contain five or six times their volume of carbonic acid gas; the salts which they contain are muriates and carbonates of lime and magnesia, carbonate and sulphate of iron, &c. The waters of Bath, Buxton, Bristol, Vichy, Seltz, &c. are acidulous.

The *sulphureous* waters are easily recognised by their disagreeable smell, their property of tarnishing silver and copper, &c.; the springs at Harrowgate, Moffat, Aix-la-Chapelle, Aix, and others, are of this class.

Paris establishes the principle, that the most soluble salts exert the highest effects on the animal economy, therefore, that all efficient mineral waters contain them, even though masked by new forms. He hence infers, that the contents are to be regarded as muriate of lime, and sulphate of soda, though analyses give sulphate of lime and muriate of soda; and so as to carbonate of iron, which he considers a true muriate. Murray concurs, and advises the consideration of all the acids and bases, and deductions drawn as to their possible soluble salts, as the true principles of the water.

MINING, the exploring and extraction of ores and mineral substances. —*See* METALS, COALS, IRON, COPPER, ORES, &c.

MINT. *Bergamot Mint*, *Pepper Mint*, *Horse Mint*, *Water Mint*, *Penny Royal*, *Spear Mint*, *Bushy Red Mint*, *Hart's Penny Royal*, are stomachic, and promote digestion. They are diuretic and emmenagogues, either in powder or infusion; and they yield, on distillation, a fragrant oil.

Mint may be raised by parting the roots from an old bed, in any of the winter months, and covering them with about two inches of mould. When the shoots from an old bed are about three inches high, they are cut about two inches deep in the ground, and these are planted about six inches apart in well manured ground, in beds of about four feet wide. It should not stand above three or four years on the same land, as it gets weak and rubbishy.

Wild mint keeps away mice from corn stacks, and also from cheese rooms.

MISSELTOE.—Berries are very purgative, and used to make bird-lime. The leaves are anti-epileptic, in doses of 1 scr. to 1 dr. twice a day. The *Misseltoe of the oak* was esteemed a sacred plant by the Britons. The common kind, which seldom grows on the oak, is used as a substitute.

MITES may be kept out of meal by placing nutmegs in it; or some skinned branches of lilac or elder.

MODULUS OF ELASTICITY, or stiffness, in thouands of feet.

| | |
|---|---|
| Iron and steel ....... | 10,000 |
| Fir-wood............ | 10,000 |
| Crown glass ......... | 9,800 |
| Elm and beech ...... | 8,000 |
| Copper .............. | 5,700 |
| Brass, oak, and box . | 5,000 |
| Silver .............. | 3,240 |
| Tin ................. | 2,250 |
| Ice ................. | 850 |

Stiffness is the power of resisting flexure. It is directly as the breadth and the cube of the depth, and inversely as the cube of the length. If the ends are fixed, as well as supported, the stiffness is quadrupled. If hollow, and of equal weight and length, the stiffness is as the square of the diameter. To find the flexure of a beam of fir, loaded in the centre, multiply the cube of the length, in inches, into the weight in lbs. and divide by the cube of the depth, and 10 millions the breadth.

MOLECULE, is a name given to those primary atoms of matter which are imagined to be the basis of the material world. They cannot be such as are no longer divisible, but only the smallest which, in relation to others, are capable of generating phenomena, since matter is indefinitely divisible. But the wretched state of philosophical ideas may be inferred from the recent publications of a Mr. Brown, who has been distinguished for them in learned societies. This person found that, by reducing any bodies to such fine powder, as that 20,000 were but an inch in length; and, putting them in water, they moved and performed rotations. He then inferred that they were living atoms, *ergo*, that all matter is composed of atoms, of which life is an essential principle. We might, on this notion, wonder that, in quarrying marble, a block does not sometimes prove a steam-engine! Mr. Brown, with the schools, considers life as a principle, and not as a necessary result of arrangement and *derived* power. Again, he gravely tells us, that the motions arise from no current in the fluid, forgetting that a current would not move each, but all alike. Further, that it arose from no attractions and repulsions, a reason good enough for the schools; but, to common sense, it would be as strange as their principle of life, or the currents, if the bodies had pushed each other together by a force from their opposite sides, which attraction requires; or, acted with force, in a coutrary direction to that in which they were moving, which mutual repulsion requires! If it did not occur to him it will, however, occur to the most listless of readers, that he put his powders into *water* which had been, or might have been, *ice;* and that it had been converted from *ice* into *water*, by the *atomic motion*, called heat; and, therefore, as water, and not ice, its atoms were in sufficient motion for the state of fluidity. The motions of the atoms, consequently, would be a *necessary* result of placing them amidst atoms in great motion. Mr. Brown, therefore, proved nothing about a moving or vivacious principle in the atoms, but accidentally confirmed what Lewenhoeck, Hooke, and others, had long ago discovered, that high magnifiers display all very small atoms in motion. If Mr. B. by more motion had converted his ice into gas, *i. e.* if he had applied atomic force enough to overcome the atmospheric pressure which kept down the fluid as such, he would have had a medium of still greater mobility, and have had occasionally still more motion in his atoms. The principle of all gas being then the same, we are not to wonder that our microscopic observers in air find the evidence of life, which mere motion affords, in all atoms that are but the 20 or 30 thousandth of an inch in diameter. They are the dust of the atmosphere. The subject is curious, since we have in it a test of the relative momenta of atoms in fluids and gases; and it has been worthy of this notice, as an occasion for exposing the confused jargon of our schools of philosophy on every subject. Mr. B. even talks of his primitive molecules, while the atoms of water, in his vision, were forgotten. Dr. Crichton, a few years since, amused the world with a similar tissue of odd errors.

MOLYBDEUM is a metal of chemistry.

MONEY, is the convenient and portable representation of property, whose value is determined by stamps, or marks of authority, or credit. It may be gold, silver, copper, paper, or any material which will receive a mark to designate its current value in goods, necessaries, or property of any kind. Being, in general, imperishable, crafty persons hoard it, to the great inconvenience of the community; and these let it out for hire, at a given rate of usury, or interest, which bad laws tolerate, for being created as mere convenience to prevent the trouble of barter, the hoarding is always a crime against society, and a usurer is, therefore, a public nuisance. The money of England is, the gold *sovereign*, or pound sterling, of which there are 46½ in a lb. of gold, of which two parts in 24 are copper, to harden. The silver *shilling*, of which 66 are a lb. of silver, with 1-12·5th copper, to harden. And the *penny*, of copper, of 16 to the lb. There are, besides, Bank of England notes, of £5 and upwards, issued on the credit of that establishment; and notes of provincial bankers of £5 and £10, issued on their respective credits. This is the currency of England, and the standard of value, by which all goods, labour, and property is estimated. Of course, therefore, these are more or less dependant, in their relative nominal value, on the greater or less quantity of the standard currency in circulation, while under certain circumstances the ratio varies as to particular goods, or properties, differently from the ratio of the standard currency to all property and transactions. Great social and personal mischiefs arise, therefore, from variations and experiments on the currency; and the prosperity or adversity of a country is decided by the wisdom or ignorance of its rulers in this respect. General currency, as gold, silver, and bank-notes, serve the general purposes of money-dealers and usurers; but diffusive national industry and local prosperity depend entirely on local creations of currency, issued on the credit of character. The former represent the sea and great rivers, for grasping speculation; the latter, the springs, rivulets, and canals, which fertilize and fructify every acre, and promote the comforts of every fire-side. For this purpose, one-pound notes were of incalculable benefit, and this benefit ought to have been continued and secured, and not withdrawn by the machinations of scholastic theory and ministerial ignorance.

In America there are dollars and copper cents, but all the benefits of currency are enjoyed in a paper currency, issued by local banks of undoubted credit, and controlled by published accounts of issues and resources.

*Value of Foreign Money, in English Currency, sufficiently near for ordinary purposes:—*

| | | £ | s. | d. |
|---|---|---|---|---|
| Sol .. .. .. | French | 0 | 0 | 0½ |
| Sous .. .. .. | Ditto | 0 | 0 | 1 |
| Livre and Franc | Ditto | 0 | 0 | 10 |
| Louis, or Napoleon | Ditto | 0 | 16 | 8 |
| Louis d'Or .. .. | Ditto | 1 | 0 | 0 |
| Rial .. .. .. | Spanish | 0 | 0 | 5¼ |
| Ducat .. .. | Ditto | 0 | 6 | 9 |
| Piastre .. .. | Ditto | 0 | 3 | 7 |
| Dollar .. .. | Ditto | 0 | 4 | 6 |
| Pistole .. .. | Ditto | 0 | 16 | 9 |
| Crusade of Exch. . | Portugal | 0 | 2 | 0 |
| Moidore .. .. | Ditto | 1 | 7 | 0 |
| Florin .. .. | Flanders | 0 | 1 | 8 |
| Ducat .. .. | Ditto | 0 | 9 | 3 |
| Rix-Dollar .. | German | 0 | 3 | 6 |
| Rix-Dollar (24 Groschen) .. .. | Prussian | 0 | 3 | 4 |
| Rix-Dollar .. | Holland | 0 | 4 | 6 |
| Stiver .. .. | Ditto | 0 | 0 | 1½ |
| Guilder .. .. | Ditto | 0 | 1 | 9 |
| Rupee .. .. | Bombay | 0 | 2 | 3 |
| Gold Rupee .. | Ditto | 1 | 15 | 0 |
| Rupee .. .. | Bengal | 0 | 2 | 6 |
| Pagoda .. .. | Ditto | 0 | 8 | 9 |

MORPHIA.—To obtain this substance from opium, free from narcotine:—Evaporate to the consistence of an extract a spirituous solution of opium; then, by successive solutions and filtrations, separate all the resinous matter of the extract, which separates the narcotine from the morphia: long ebullition with calcined magnesia, a series of filtrations, and washings and dryings, yield very pure morphia, free from narcotine. When the resinous matter is dissolved in dilute sulphuric acid, and the solution decomposed by potash, the narcotine is precipitated, which is purified by a fresh solution in sulphuric acid and precipitation by ammonia, and this often, after filtration, washing, and redissolving in alcohol of 0·903, crystallizes. A lb. of opium yields, by this process, 8 drs. of perfectly pure white crystallized morphia.—*Ann. de Chim.*

MORTAR, is a cement, made by expelling, by fire, the oxygen from carbonate of lime, or limestone, and mixing water with sand, or ashes, as a paste. Then, as the oxygen speedily recombines with this hydrate of lime, the mortar sets as limestone again, and increases in hardness with age.

Mortar is often used of two qualities, or proportions of sand—the greater for inside joints, and the less for outside; in which the sand-mortar, for pointing, is often mixed; is finer also, with forge-ashes, but white cement is also used.

Mortar, for paving, is improved by mixing the residuum of the distillation of aquafortis.

MOTHER WATER.—When sea-water, or any other solution containing various salts, is evaporated, and the crystals taken out, there always remains a fluid containing deliquescent salts, and the impurities, if present. This is called the mother-water, and requires to be variously treated, according to the nature of its contents.

MOTION, LAWS OF, first published by Descartes, and adopted by Newton.

1. That every body continues at rest, or in rectilinear motion, unless affected by some mechanical agency.

2. Changes are in the direction and quantity of the force impressed.

3. Action and reaction are equal, but directed to contrary parts of external space.

But these axioms are directly opposed to all assumptions of attractive, repelling, and gravitating powers of matter, and were written by Descartes, who was a materialist, for the purpose of exploding all such pretended powers of matter. He also believed that no motion is ever created, only concentrated; not lost, only dispersed and rendered insensible. Motion is the change of place in a body, during which it has the power of making other bodies change their places, and dividing its power of change with them. The communication of the motion is called action in the communicator, and reaction in the receiver. The results are all the phenomena of the universe.

MOULDINGS, in Architecture, are the annular, the astragal or bead, the ogee, the cuna recta, the cavetto or hollow, the ovolo, the scotia, and the torus.

MOULDINESS may be retarded by the presence of aromatics. It is a plant propagated by seeds.

MOUNTAIN-ASH, is a very ornamental tree, which flourishes in elevations of 2000 feet, and produces a firm hard wood, and the best bark for superior tanning.—*Sinclair's Code.*

MOUNTAINS.—It appears, from a great variety of observations, that the internal part of the globe consists of the stone called granite. It is this which shows itself as the limit of all the excavations made on the surface of our planet, either by natural causes, or the art of man.

The first effect of rain was to depress the mountains. But the stones which compose them must resist in proportion to their hardness; and we ought not to be surprised, when we observe peaks that have braved the destructive action of time, and still remain to attest the primitive level of the mountains which have disappeared. The water which falls on their summits, flows down in torrents by their lateral surfaces. In its course it wears away the soil upon which it incessantly acts. It hollows out a bed of a depth proportioned to the rapidity of its course, the quantity of its waters, and the hardness of the rock over which it flows; at the same time that it carries along with it portions and fragments of such stones as it loosens in its course. These stones, rolled along by the water, must strike together, and break off their projecting angles; a process that must quickly have afforded those rounded flints which form the pebbles of rivers.

The pulverulent remains of mountains, or the powder which results from the rounding of these flints, are carried along with greater facility than the flints themselves: they float for a long time in the water, the transparency of which they impair: and when these said waters are less agitated, and their course becomes slackened, they are deposited in a fine and light paste, forming beds more or less thick, and of the same nature as that of the rocks to which they owe their origin.

The mud is much more frequently deposited in the interstices left between the rounded flints themselves, which intervals it fills, and there forms a true cement, that becomes hard, and constitutes the compound stones known by the name of pudding-stones and grit-stones.

We sometimes observe the granite spontaneously decomposed. The texture of the stones which form it has been destroyed; the principles, or component parts, are disunited and separated, and they are gradually carried away by the waters. It appears that feldspar is particularly subject to be altered the first.

Most silicious stones, formed by the deposition of fluviatile waters, and hardened by the lapse of time, are easily subjected to a second decomposition.

Iron is the principal agent of secondary alterations; and its oxidation, determined by air or water, produces a disunion of principles. Nature may be observed in this process, by an attentive examination of such alterations as gun-flints, variolites, porphyries, jaspers, and the like, are subjected to.

Water filtrating through mountains of primitive rock frequently carries along with it very minutely-divided particles of quartz; and proceeds to form, by deposition, stalactites, agates, rock crystal, &c. These quartzose stalactites, differently coloured, are of a formation considerably analogous to that of calcareous alabasters; and we perceive no other difference between them than that of their constituent parts.

Metals, sulphur, and bitumens, appear to be posterior to the existence of this primitive globe; and the alterations and decompositions, which now remain to be inquired into, appear to be produced by the class of living or organized beings.

On the one hand we behold the numerous class of shell animals, which cause the stony mass of our globe to increase by their remains. The spoils of these creatures, long agitated and driven about by the waves, and more or less altered by collision, form those strata and banks of lime-stone, in which we very often perceive impressions of those shells to which they owe their origin.

On the other hand we observe a numerous quantity of vegetables, that grow and perish in the sea; and these plants likewise, deposited and heaped together by the currents, form strata, which are decomposed, lose their organization, and leave all the principles of the vegetable confounded with the earthy principle. It is to this source that the origin of pit-coal, and secondary schistus, is usually attributed.

The formation of pyrites ought to be attributed to the decomposition of vegetables. The decomposition of animal substances may be added to this cause: and we find many shells passed to the state of pyrites.

Not only the marine vegetables form considerable strata by their decomposition; but the remains of those that grow on the surface of the globe ought to be considered among the causes or agents which concur in producing changes.

The calcareous mountains are constantly placed upon the surface of the primitive mountains. Sometimes even the lime-stone fills to a very great depth the crevices or clefts formed in the granite. It likewise happens, that waters loaded with the remains of the primitive granite heap them together, and form secondary granites, which exist above the calcareous stone. These calcareous mountains are decomposed by the combined action of air and water, and this fluid in solution soon deposits it in the form of gurhs, alabasters, stalactites, &c. Waters wear down and carry away calcareous mountains with greater ease than the primitive mountains. The fragments of these rocks are sometimes connected by a gluten, or cement, of the same nature; from which process calcareous grit and breccias arise. These calcareous remains, deposited upon the quartzose sand, and the union of primitive matter and secondary products, give rise to rocks of a mixed nature.

The mountains of secondary schistus afford, by analysis, silex, alumine, magnesia, carbonate of lime, and iron; principles which are more or less united.

These same principles, carried away by waters, give rise to a great part of the stones comprised in the magnesian genus, and the same, deposited under circumstances proper to facilitate crystallization, form the schorls, tourmaline, garnets, &c.

It frequently happens, that the secondary schisti are interspersed with pyrites ; and, in this case, the simple contact of air and water facilitates their decomposition. Sulphuric acid is thus formed, which combines with the various constituent principles of the stone ; whence result the sulphates of iron, of magnesia, of alumine, and of lime, which effloresce at the surface, and remain confounded together.

The pyritous schisti are frequently impregnated with bitumen, and the proportions constitute the various qualities of pit-coal. Pyrites is abundant in proportion as the bituminous principle is more scarce. Hence it arises, that coals of a bad quality are the most sulphureous, and destroy metallic vessels by converting them into pyrites.

The remains of terrestrial vegetables exhibit a mixture of primitive earths more or less coloured by iron : we may therefore consider these as a matrix, in which the seeds of all stony combinations are dispersed.

The ochreous earths constitute one of the most fertile means of action that nature employs.

The spoils of animals, which live on the surface of the globe, are entitled to some consideration among the number of causes which we assign, to explain the various changes our planet is subject to.

To these silent and constant causes of change may be added a still greater, in the alternate preponderance of the sea, in both hemispheres. It now covers the Southern hemisphere, and has done so for nearly 6000 years, but in another 4000 years it will begin to pass to the Northern, and in 5000 will cover the same proportion of the Northern hemisphere as it now covers of the Southern, for other 10,000 years. The period is 20930, that of the Line of Apsides, and the effect mechanically arises from one end of that line being the Perihelion distance, and the other the Aphelion. The reaction of the earth is increased while in the Perihelion, and the mobile waters are the means. These then follow the Perihelion through the ecliptic, and when it is in the Northern signs, the waters deluge the Northern hemisphere; and when in the Southern, the Southern hemisphere, as at present. The elevation is about 1200 or 1500 feet above the present level, rendering the Alps, Pyrennees, &c. islands in a vast ocean ; and overturning all the present forms of land, as the bed of its tides and oscillations. We cannot, therefore, wonder at the extinct creations which the strata present, since every one of them are indexes of one of these Perihelion submersions; nor at the phenomena of localities where tides have advanced or receded for 2 or 3000 years, during the rise and retreat of the ocean. The motion is not doubtful, the effects are consequences of it, and they are visible in the ruins and disposition of the entire surface.

MUCILAGES, are gummy solutions, in water, of acacia, gum-arabic, tragacinth, and starch. They are also common animal and vegetable fluids.

MUDARINE.—The root of the mudar or mudbar plant, the *calotropis mudarii*, of Hamilton, belonging to the *asclepiadeæ*, well known in the East as a powerful medicine. The most remarkable peculiarity of mudarine is, that its solubility in water diminishes as the temperature increases. A concentrated solution, which is perfectly transparent and fluid at 50°, has its transparency diminished, and gelatinizes at a little above 70°. On being allowed to cool, the jelly melts, and regains its former fluidity. If the temperature be raised considerably above 70°, the jelly contracts and separates from a liquid, and it has lost its power of resuming its liquid state on reduction of temperature.

MUFFLE, is the name of a system of double pulleys, moved together with parellel cords, the power of which is as the number of cords at the lower block. It is also a portable oven or furnace.

MULBERRY, a very important genus of trees, whose fruit yields tartaric acid, its leaves silk, its bark paper and useful wood. The black species produce the best fruit, the white such leaves as silk-worms prefer, and in which the fibrous tissue is visible ; and the paper species, of whose fibrous bark cloth is made in the South Sea Islands, and paper in Japan. It may hence be concluded, that the origin of silk is vegetable, and that it is merely softened and elongated by the worms. The coarser fibre of the bark is further proof that the mulberry has a peculiar fibrous tissue.

The quickest and most certain mode of raising the mulburry-tree is, from cutting the old branches. Take a branch in the month of March, eight or nine feet in length, plant it half its length in any good soil, and it will produce fruit the following year.

MULE, is the produce of a jackass with a mare, and has a large clumsy head, long erect ears, a short mane, and a thin tail. The produce of a she-ass and a stallion, called bardeau, by Buffon, is a much inferior animal. The head is long and thin, the ears are like those of a horse, the mane is short, but the tail well filled with hair.

These animals are mostly sterile; some, indeed, have thought that they are altogether incapable of producing their kind; but some few instances have occurred, in which the female mules have had foals, and in which the male has impregnated females, both of the ass and horse species; but such instances are very rare. They are much hardier than the horse, cheaper kept, subject to fewer diseases, and will live and work twice as long. They take so much after the mare from which they are bred, that they may be procured of any kind, light or strong, as the owner pleases.

MULE, in manufactures, is a machine, invented by Crompton, for producing finer yarn, and has now quite superseded the jenny. For producing threads of the finest kind, a process is necessary which is called stretching, and analogous to that which is performed with carded cotton upon a common spinning-wheel. The spindles are mounted upon a carriage, which is moved backwards and forwards across the floor, receding when the threads are to be stretched, and returning when they are to be wound up. The yarn produced by mule-spinning is employed in the fabrication of the finest articles, and threads have been produced of such fineness, that a pound of cotton has been extended to 300 hanks, or 167 miles.

MULLER, is the name of a stone for grinding colours, usually flat, and worked with the hand, or with a horse and a wheel. But a concave muller has been invented, which, being placed vertically, and the concavity supplied with rough colour, it is pressed and worked by another stone, worked with a winch or power. The muller is a segment of the turning-stone.

MULTUM *(for Brewers, instead of malt and hops.)*—To each quart of extract of quassia add 40 oz. of liquorice-root.

MURIATE OF SODA.—*See* SALT.

MURIATIC ACID, *marine acid, spirit of salt, hydro-chloric acid*, as a gas, was unknown till 1772, when it was obtained by Priestley. It is now procured in the gaseous form, from the decomposition of *common salt by sulphuric acid*, and may be collected by delivering it from the gas-bottle through a narrow tube, at the bottom of a phial or jar, for having sp. gr. 1·259, it displaces the air, and occupies the vessel. If an inflamed taper be immersed in it, it is immediately extinguished, and it is destructive of animal life.

The common process for obtaining *liquid* muriatic acid is, to take of common salt, sulphuric acid, and water, equal weights. Then the acid is mingled with one-third of water, and, when cold, poured on the salt; the gas evolved is conducted through reservoirs of water, and subjected to pressure in contact with it. It combines, like the other powerful acids, with the alkalies, earths and metallic oxides, forming a peculiar class of salts, called *muriates*.

The proportions in making it are, 5 parts of concentrated sulphuric acid, poured upon 6 of dry sea-salt. The effervescence is then made to pass through a tube filled with ignited muriate of lime.

*Or*, for liquid, by mixing 10 oz. of sulphuric acid, with 1-4th of a pint of pure water in a glass retort, and when cold adding 1lb. of dried or burnt salt. Pour half-a-pint of water into the receiver, and distil the muriatic acid into it in a sand-bath till red-hot. The sp. gr. should be 1·16, and 50 grains are saturated by 62 of subcarbonate of soda.

It is a compound of oxygen and sea-salt, which is its base, just as sulphur or phosphorus are the bases of their acids. It is the acid of soda, and very potent in its operation when saturated with another dose of oxygen, by pouring it over gray manganese, as *oxymuriatic acid*, or chlorine. 100 oz. of salt yield 62 of muriatic acid gas; other doses of oxygen have also been added, to which chlorine names have been given. Two parts of it, mixed with one of nitric acid, makes the famous *aqua regia*, which alone dissolves gold and platinum. In manufactories, iron retorts are used.

Davy taught that dry salt consisted of 36 of his chlorine, and 24 of the metal sodium, and that 100 parts of the acid contain 2·7 of hydrogen and 97·3 of chlorine; but this is a mistake, and 1 of hydrogen ought rather to be added to the sodium, as 25 or 24.

*Muriate of lime* is now called *chloride of calcium*; but muriatic acid is, per Berzelius, 28 nearly, and lime 28 = 56. And chlorine is 36 nearly, and calcium 20, making also 56. Consequently, in the last process, the calcium is converted into lime, and the chlorine into muriatic acid.

*Muriate of soda*, common salt, is now called chloride of sodium. But the change of name is apparently without reason, since muriatic acid is 28, and soda is 32, making 60; and chlorine is 36, and sodium 24, also equal 60. The chlorine holds the oxygen which the soda possesses, and this extra dose in the chlorine merely performs the same function as the extra dose of the oxygen in the soda. It appears, to prove that chlorine is merely muriatic acid with an extra dose of oxygen, or, as it has always been called, *oxy-muriatic acid*. As the numbers are correct there appears to be no escape from this conclusion, and analogy of nomenclature demands the restoration of the primitive name *oxymuriatic acid*, and the banishment of the affected term *chlorine*, making a distinction without a difference. It is the oxidized acid of salt.

*Muriatic gas fumigations*, often called chlorine fumigation, are made by mixing 1 part of powdered manganese for its oxygen with 2 parts of dry salt in a small basin, placed in a vessel of hot sand, and pouring on it half the weight of strong sulphuric acid till fumes arise. The room should be evacuated and the doors closed, and in an hour or two the air, walls, and furniture, &c. will be completely purified.

The object of the mixture is to decompose the salt, and to add, by the manganese, to the strength of the muriatic acid; in fact, rendering it *oxymuriatic gas*.

*Disinfecting bottles*, containing a third of their bulk of manganese, nitric and muriatic acid, are also used, and may be had of the chemists, with a glass cover and screw, to regulate the diffusion.

*Muriatic water*, which acts on metals and forms muriates or chlorides, is made by gradually adding 43 parts of sulp. acid to 62 of water, and when cold pour it on 50 parts of dried salt, and 15 of powdered oxide of manganese. Then submit it to increasing heat, and pass the gas into 100 parts of pure water. This solution blanches all vegetable colours, is useful in all diseases tending to putrescence, and has been successfully applied in venereal cases.

MUSCLE consists of *distinct portions of flesh*, susceptible of contraction and relaxation; the motions of which, in a natural and healthy state, subject to the will and nerves, are called *voluntary* muscles. The heart is a muscular texture, forming what is called a *hollow* muscle: and the stomach, intestines, &c. are enabled to act upon their contents, merely because they are provided with muscular fibres, called *involuntary* muscles, not dependent on the will.

Muscles that act in opposition to each other are called *antagonists*; thus, every extensor has a flexor for its antagonist, and *vice versa*. Muscles that concur in the same action are termed *congeneres*. The muscles being attached to the bones, the latter may be considered as levers, that are moved in different directions by the *contraction* of those organs. That end of the muscle which adheres to the most fixed part is usually called the *origin*; and that which adheres to the more moveable part, the *insertion* of the muscle.

In almost every muscle two kinds of fibres are distinguished; the one soft, of a red color, sensible and irritable, called *fleshy* fibres; the other of a firmer texture, of a white, glistening color, insensible, without irritability, or the power of contracting, and named *tendinous* fibres.

Muscle is found to consist chiefly of fibrine, with albumen, gelatine, extractive, phosphate of soda, phosphate of ammonia, phosphate and carbonate of lime, and sulphate of potash. Every muscle abounds in arteries, veins, and nerves. When a muscle acts, it becomes shorter and thicker; both its origin and insertion are drawn towards its middle. The sphincter muscles are always in action; and so likewies are *antagonist* muscles, even when they seem at rest. When a muscle is wounded, or otherwise irritated, it contracts independently of the will: this power is called *irritability*, and it is a property peculiar to and inherent in the muscles.

The intensity of muscular contraction, that is, the degree of power with which the fibres draw themselves together, is regulated by the action of the brain, within certain limits, which are different in different individuals. For the cerebral influence, and the disposition of the muscular tissue, are the two elements of the intensity of muscular contraction, and a very great cerebral energy is rarely found united, in the same individual, with that disposition of the muscular fibres which is necessary to produce intense contractions: these elements are almost always in an inverse ratio.

MUSCOVY GLASS, consists of broad, elastic, flexible, transparent leaves, and differs externally from mica, only in being softer, and more soapy to the touch. It is capable of being split into laminæ of the two or three hundredth part of an inch thick, and the plates naturally exhibit a strong electric state, and sparks, when torn asunder in the dark, even though previous friction be carefully avoided. Few specimens are as transparent as glass, and are used for glass in many parts of Asia.

MUSK, (*grain*,) obtained from musk pods, smells the strongest of any natural substance, and, in very small quantity, augments the smell of other substances.

Musk, (*artificial*,) is made of rectified oil of amber one part, nitric acid four parts, and digested. Black matter is deposited, to be well washed in water, and it smells similar to musk or ambergris, and may be used for them.

*Musk Bolus*. Mix in simple syrup 15 grains of musk with 5 grains of camphor. *Or*, with conserve of roses, half a scruple of musk and of sal ammoniac.

MUSKETS, are bored on the principle of turning from a square length of iron, welded on a mandrel by heat into cylinders. In forming the spirals of rifle barrels, the borer is conducted by a matrix or female screw, which revolves in 2 feet, and the borer is fixed to a male screw. The spiral threads in a barrel are from 3 to 12. Cannon are cast as cylinders, and then bored.

The cylinders of steam-engines are of solid cast-iron, bored in the usual manner, by forcing the cutters by a train of wheels towards the solid cylinder.

MUST, is the expressed juice of grapes, of apples, of pears, &c. A pint of grape Must yields half an oz. of sugar and a dram of tartar. Some grapes afford a full third of saccharine matter.

MUSTARD (*Sinapi*,) seeds unbruised, are stimulant, and generally laxative; they cure vernal agues; and are pressed for their oil. The farina of the seeds is used as a rubefacient, and as seasoning in diet.

*Mustard Flour* as a paste, with crumbs of bread and turpentine, may be often applied for the purposes of a blister, and it is far more powerful. A tablespoonful in a pint of warm water is a quick emetic.

*Patent Mustard.* In 15 gallons of water boil 10 lbs. of salt, and 12 lbs. of black ginger, strain, and to each gall. add 5 lbs. of flour of mustard.—For *Moutarde à l'estragon.* In a quart of Terragona sugar mix 2 oz. of salt, and 1 lb. of black mustard-seed, much dried, and finely powdered. This is the favourite French mustard.

MUTTON, the flesh of sheep, eaten by men. *Mutton hams* are legs salted and smoked, or dipped in pyroligneous acid two or three minutes, and dried;—skins tawed, are *white leather*; tanned, are *basil skins*, and they are also made into parchment. The *skulls*, bladebones, &c. are used to make portable soup and bone glue, as well as the trimmings of sheep-skins cut off by the tanners. The horns, rubbed upon heated iron or steel tools to varnish them.—*German sausage skins* are prepared from the intestines. The epidermis, torn from the skins, after soaking in water, makes chamois leather, and larger pieces are used to make gloves, called *French chicken skin gloves*, packed and sold in a walnut-shell.

*Sheep's dung* is used in dyeing, for the purpose of preparing cotton and linen to receive certain colours, particularly the red of madder and crosswort.

MYRRH, tincture of, is made by digesting, for 7 days, 3 oz. of powdered myrrh in a quart of proof spirit, and filtering. It is an excellent wash for the teeth and gums.

MYRTLE WAX, is a concrete oil, or vegetable wax, the product of the class of plants *myrica*, known by the name of *candleberry myrtle*. It has too long been considered merely as an object of curiosity. The plant abounds in nearly all parts of North America, and varies in size from 4 to 18 ft. becoming taller as it extends into warmer regions. The bush or tree has somewhat the appearance of the common myrtle, and bears a berry of the size of the pepper-grain or coriander-seed. These grains are of a common ash-color, containing a small, round, hard kernel, which is covered with a shining wax, that may be obtained by boiling the grains in water. The wax is prepared for commerce along the Canadian lakes, and might, by proper attention, be rendered an important article of traffic.—Tapers made of it emit, when burning, the most delicious and balsamic odour, and the light is white and intense, equal to the best wax-candles.

NAILS, are commonly made by hand by men or women, and also by machinery, invented by Church, the facility of which is so great, that the daily product is that of 12 workmen. A nail-smith, in Stirling, lately undertook to make 17,000 double flooring nails, 1200 to a thousand of 20 lbs., for two successive weeks. He finished his first week's task by three o'clock on Saturday afternoon; resumed his labour on Monday morning, and concluded his second week's task with more ease than the first. The quantity was as much as three ordinary men can perform, and allowing 25 strokes of the hammer (which was 2 lbs. weight) to each nail, there were no less than 1,033,656 strokes required. In addition to this, he had to give from one to three blasts with his bellows for every nail, and had to move from the fireplace upwards of 42,836 times.

NAPHTHA, the most fluid bitumen, is nearly colourless, but of a yellowish tinge, transparent, and emits a peculiar odour. It swims on water, its specific gravity being from 0·71 to 0·84. It burns with a bluish-white flame and thick smoke, and leaves no residue. It consists of carbon, 82·2, and hydrogen, 14·8; being the only fluid destitute of oxygen. It is found in Persia, in the peninsula of Apcheron, upon the western shore of the Caspian Sea, where it rises through a marly soil in the form of vapour, and, being made to flow through earthen tubes, is inflamed for the purpose of assisting in the preparation of food. It is collected by sinking pits several yards in depth, into which the naphtha flows. It is burned in lamps, by the Persians, instead of oil. Near the village of Amiano, in the state of Parma, there exists a spring, which yields this substance in sufficient quantity to illuminate the city of Genoa, for which purpose it is employed.

NAPHTHALINE, is a semi-fluid, which comes over in the distillation of coals for gas.

NARCOTINE. — Evaporate opium; dry; add muriatic acid, or pyroligneous acid, at 4° or 5°; press out the liquor, add ammonia, wash the precipitate with boiling alcohol, at 36°, cool, and the narcotine will separate, and is purified by bone black.

NASTURTIUM, (*Indian cress*,) is eaten in salads, and is anti-scorbutic. It excites the appetite, and assists digestion. Externally it is used in stubborn itch.

NAVIGATION BY HORSE-POWER. M. De Riva has perfected a machine, constructed partly of cast and partly of wrought-iron, which is set in motion by eight horses, and drives two paddle-wheels in the same way as if steam had been applied. It is also capable of giving the wheels a retrograde motion, and raises and depresses the wheels as occasion requires; by which last operation their occasionally excessive dip into the water, which derogates from their power, is remedied. This machine has been fitted up in a vessel of 100 tons, and she has made several trips with satisfactory results.

A similar vessel was in use 300 years since, and oxen were used instead of horses. For ferry-boats, with large decks and little draught of water, they seem well calculated.

NEGATION is a *relative* idea, with reference to some other number or quantity, positive in relation to some standard; thus fractions are negative, with reference to whole numbers, and, in similar *relations*, algebra presents negative quantities, always distinguished by the mark —.

NERVES.—The nerves of the animal frame are composed of bundles of white parallel medullary threads, acting the part of bell-wires on the animal system. Every bundle is surrounded with a soft sheath filled with blood-vessels, whose finest branches terminate in the substance of the nerves. These nerves are spread through the whole animal frame, and variously connected with each other. Only the epidermis, the hair, and nails are destitute of them. They are of various size, according as they are composed of more or fewer bundles of medullary threads. In the course of the nerves there are a number of knots; which are called *ganglions*. They are commonly of an oblong shape, and of a grayish colour somewhat inclining to red, which is, perhaps, owing to their being extremely vascular. In particular parts of the body, the nerves come in contact with each other, and the bundles composing them are mutually interwoven to such a degree that they cannot be disjoined without violence. These communications are called *plexuses*, and are found particularly in the abdomen and in the region of the pit of the stomach, near the liver, mesentery, heart, &c.

The *nervous system* is most intimately connected with the brain and the spinal marrow, which may be regarded as a prolongation of it. The brain is the centre, from which or to which proceed all impressions communicated to the nerves. The substance of the nerves is the same medullary matter which constitutes the brain, resembling the white of an egg, and appearing, to the unassisted eye, as if composed of little balls. The central termination of all the nerves is in the brain and spinal marrow, whence they branch out into the skin or the interior of the organs.

The isolated, and, in part, heterogeneous structures of which the body consists, which are mechanically joined by the cellular tissue, the membranes, and the ligaments, are united into one harmonious whole by means of the nerves. Another part of the nervous system affords the means of consciousness and voluntary action. This is the *brain*, or *cerebral system*, which excites the nerves that put in action the muscles of voluntary motion, and those which supply sensibility to the organs of sense, and convey to the brain the impressions thence received.

The nerves communicating with the organs of sense run in pairs—the first pair (olfactory nerve,) to the nose, where it is spread over the surface of the nostrils, and forms the power of *smell*. The second (optic nerve,) to the *eyes*; this is round, thick, and penetrates from behind the ball or globe of the eye (through a round plate of the firm coat of the ball, containing many little apertures,) and is spread out on the inner and concave surface of the globe into a thin coat called the *retina*, on which the images of external objects are formed. The eighth pair, *auditory*, are spread over the interior of the ear, and are sensible to the vibrations of the air. From the numerous ramifications of the ninth pair come the nerves of the tongue, which give rise to the sense of *taste*. The general sense of feeling is situated particularly in the skin; and peculiarly in the points of the fingers. This sense is produced by a variety of nerves, diffused over the skin, and those parts which are most sensitive are supplied with the greatest quantity of nerves, which form entire series of contiguous nervous *papilla*; for instance, at the lips, the points of the fingers, &c.

NEUTRAL SALTS.—This term is applied to all salts which contain an acid saturated with an alkali, an earth, or a metal. Bergmann confined it to salts containing alkali; and he called the earthy and metallic salts, middle salts. It is most usual to call the alkaline salts with an acid neutral, and to distinguish the others by the respective appellations, earthy and metallic.

NEWSPAPERS are useful chronicles of the events of the times, if conducted with honesty and impartiality; but these are seldom their characteristics. By division of labour and compilation they are easily prepared. In a daily London paper, the foreign gazettes are translated and supplied by persons connected with the Post-office. London news is supplied by sundry collectors and reporters, paid per quantum used; parliamentary debates by sets and relays of reporters for the session; country news by the provincial papers; with a few paragraphs and leaders of the editor. Provincial papers are made up from the London papers, with extracts from other local papers, and a few original paragraphs, with marriages, deaths, and prices of markets. A daily paper employs from 15 to 20 compositors in setting the types, besides presses and machines. A provincial weekly paper from three to four compositors. The sale of 750 copies and about 25 advertisements pay the expences of a provincial paper; but a London one requires double that patronage. Many in the country sell 3000, with 100 advertisements, and some London ones 8 or 10,000, with more advertisements than they can insert. Almost every paper is printed for a class or party, in support of which the conductor is expected to be a zealous advocate.

NICKEL, is a silver-like metal, sp. gr. 8·9. It is magnetic, and is greedy of oxygen, forming gray protoxide and black peroxide. Heat will not oxydate it because it drives off oxygen as fast as it fixes; but the oxides are formed by solution in nitric acid, precipitating by potash, and then heating to redness.

NITRE, or Saltpetre, is one of the important class of bodies called nitrates, and nitre is nitrate of potash, a composition of nitric acid with the alkali, potash, in the proportions of 48 potash to 54 nitric acid, making the equivalent 102. Nitric acid is a product of animal substances and excrements, and has been generated by natural operations in several countries, but is artificially prepared in Egypt by trenches of animal substances, aided by access of air, to supply oxygen. Earths, with vegetables, make saltpetre, but with earths potash; and the separation of these, by making brine and evaporating, is a tedious process, being repeated three or four times.

To purify crude or native nitre it is washed in several cold waters, and then macerated with half its weight of water. After a pellicle forms it is poured into lead coolers, and stirred till cold, when the pure salt is precipitated in crystals, and is then, in chemical language, called pure nitrate of potash, or, in popular language, pure nitre. 100 consists of 48·64 potash and 51·36 nitric acid; *i. e.* $48 + 54 = 102$, as the equivalent.

Nitre, in various relations to the arts, to medicine, &c. is one of the most useful of substances.

3 nitre, 2 subcarbonate of potash, and 1 sulphur, mixed in a warm mortar, form the *fulminating powder* which explodes in a spoon over a candle, or a shovel over a fire. Charcoal, put for the subcarbonate, with other proportions, nearly as 8, 2, and 1, are gunpowder. 1 of saw-dust put for the subcarbonate, makes the fusing-powder which converts a piece of copper, covered with it, into a globule of sulphuret of copper.

Five parts of *nitrate of soda*, 1 charcoal, and 1 sulphur, is the most durable powder for fire-works.

Nitrate of lime is made by pouring nitric acid on carbonate of lime. Evaporated it forms crystals and Baldwin's Phosphorus.

Nitrate of ammonia, prepared like the preceding, is a detonating substance.

Other nitrates have no remarkable character.

At a high temperature, nitrate of potash is decomposed by silex and alumina, which unite with the potash. 7 parts of cold water dissolve 2 of nitre, but seven of hot seven of nitre. Salt is as soluble in hot as cold, and, by this means, the two are separated during the preparation of nitre, since the same earths contain, also, much salt.

The nitrate of potash being procured naturally, the acid of the nitre may be obtained as nitric acid, by combining 10 of nitrate with 6 of sulphuric acid, and 2 of water; and then, by heat, a decomposition takes place, and *nitric acid* or *aquafortis* is obtained, and bi-sulphate of potash.

NITRIC ACID, or Aquafortis, is readily made by pouring, into a retort, 1 part of strong sulphuric acid, on 2 parts of saltpetre, and, with heat, the nitric acid passes over as a red, fuming, sour, and acrid liquor. Its sp. gr. is, to water, as 2 to 3, and its equivalent is 54, being a compound of 1 volume of nitrogen to 5 of oxygen, while atmospheric air is 4 of nitrogen and 1 of oxygen.

Nitric acid is manufactured with nitre

3 and sulphuric acid 2.—*Or*, nitre 5 and dilute acid 4. Under the name of aquafortis it is of extensive use.

At 1·5, nitric acid contains 79·7 of dry acid and 100 liquid acid; at 1·4, 56·57 and 71; at 1·3, 40·65 and 51; at 1·2, 27·9 and 35; and at 1·1, 14·35 and 18.

At sp. gr. 1·5, 58 of acid and 42 of water rise from 60° to 140°; and, on cooling, the volume is but 92·65. 1·5 boils at 210°; and, at 1·42, not till 248°. At 60° below Zero 1·5 is like butter.

Nitric and sulphuric acids are decomposed by all liquids, except one another and water.

Concentrated nitric acid does not act on metals; but, when mixed with water, the oxygen of the water oxydates the metals. It sets essential oils on fire. It is 25·93 nitrogen and 74·07 oxygen, and contains, at least, 20 per cent. of water.

The dilute nitric acid of pharmacy is 1 nitric acid to 9 of water, avoiding the fumes.

*Nitric acid baths* are 1 nitric, 2 muriatic, in water, to the flavour of vinegar. It promotes the nitrogenous action of the skin, and diminishes the rigidity of the bowels. Two nitric and 1 muriatic seem likely to answer better.

*To make nitric oxide gas.* Put copper clippings into a glass retort, and pour on them a mixture of two parts water and one of nitric acid.

*Nitrate of Lead* is made by dissolving lead in nitric acid or aquafortis.

*Nitrate of Silver* is made by mixing 1 fl. oz. of nitric acid with 2 oz. of water, and dissolving 1 oz. of granulated silver in the mixture on a sand-bath, till dry. Melt this gently in a crucible, and pour it into moulds. It is used in medicine for epilepsy and angina pectoris, in doses of a grain or two.

NITROGEN, the gaseous substance which constitutes four-fifths of the atmosphere, and is the substance of all alkalies, and of the several nitric acids, and the cause of all that contrasted action, with its co-gas oxygen, which creates so many terrestrial phenomena.

Its 4 vols. of 29·65 grains to the 100 inches, *i. e.* 118·6 and 1 oxygen 33·888 = 152·488 in 500 inches, and in atmospheric air are equal to 100 of 30·4976, which, in fact, is 30·519, or 40·0214 added for carb. acid, and aqueous vapour.

But, as the above ratio of nitrogen to oxygen is 3·499764, and we may presume, by all analogy, that it really is 3·561 exactly, this requires that nitrogen should be 29·650202, which gives 118·60808 for the four volumes of nitrogen; and 152·49608 for 5 volumes of air, which by 5 is 30·499216. Then, as air by experiment is 30·519, the small difference 0·01978, or only the 1537th, may be ascribed to other mixtures.

It appears, therefore, that the ratio of 3·5 nitrogen to 1 of oxygen constitute the perfect neutrality of atmospheric air; and we seem, in consequence, to be warranted in concluding, that whenever any body within air contains more or less than these proportions, the air will either alkalinize it or oxydize it, and it will be regarded, previously to such combination, as an alkali or an acid.

The ratio, then, of 3·5 to 1 is 7 to 2, or 14 to 4, or 28 nitrogen to 8 oxygen in air, though in our scale of equivalent it is made 14 to 8.

So, also, we call hydrogen to oxygen as 1 to 8, whereas $\frac{33·888}{2·118} = 16$, and 1 to 16 is the true ratio, though 1 to 8, or 2 to 16, form water, that is, 2 hydrogen and 1 oxygen.

Arithmetic ought not to yield to theory, and, at least, in such primary elements as air and water; the figures ought to harmonize with one another, and with fact. If we call hydrogen 1, then nature and figures demand that oxygen should be 16, and nitrogen 56. These numbers would then accord with air and water.

In nature, oxygen and nitrogen are connected, nearly as light and shadow, and their separation and reunion produce the phenomena of electricity, &c. with fermentation, acidification, alkalinization, &c. &c. Thus, when they are decomposed in cellars, &c. by old walls, mortar, &c. the carbon and nitrogen form the efflorescence of nitre and saltpetre, while a dose of oxygen converts it, as formed, into what is called nitrate of potash, nitrate of soda, &c. all essentially nitrogen, and the carbon bases of particular earths, with access of oxygen after the formation. As long as oxygen is fixed, the nitrous efflorescence appears. In like manner, when oxygen leaves its nitrogen in the combustion of vegetables, these absorb it, and become alkaline.

Nitrogen being itself a compound of half carbonic acid, 23·798 and 3 carbon 6·354 = 29·652, is not combustible, but there may be an alkaline base of nitrogen, as asserted by that eminent chemist Berzelius, and which he calls *nitricum*.

Nature sports in her varied compounds of the two constituents of atmospheric air. We have five of these compounds. This fundamental fluid, so important to the arranged functions of animal and vegetable life, one volume of oxygen gas, and four volumes of nitrogen gas, producing a density which weighs 30·519 grains to 100 cubic inches.

Then we have a second mixture, called prot-oxide of nitrogen, or nitrous oxide, consisting of one volume of oxygen, and only two volumes of nitrogen, which weighs 46·596 grains to the 100 cubic inches. It is half as dense again as air, two inches of it weighing more than three of air, and considering nitrogen as the diluter of oxygen, it is twice the strength, or one to two, instead of one to four. Hence, its effects when breathed are very remarkable, and it so excites the nervous system as to produce great energy of motion, and an effect on the spirits like intoxication. But, as it does not affect the stomach, it produces none of the subsequent ill effects of drunkenness. It is made by exposing nitrate of ammonia to a heat of 400°.

Then, as air is 1 oxygen to 4 nitrogen, and nitrous acid 3 to 2, instead of 3 to 12, it is six times stronger than atmospheric air, and very corrosive and pernicious to the lungs. It is made for commerce, under the name of *aqua-fortis*, by distilling, in a reverberating furnace, equal parts of purified nitre and copperas. The nitre is to be dried, and the copperas calcined to redness. The mixture is put into an iron retort, and the receiver is glass with a safety-pipe, luted to the retort, and the joint protected with canvas, and a lute of quicklime, and white of egg. Gradual heat sends over red vapours, which continue till the retort is heated to redness. The subsiding liquor is *nitrous acid*, of a yellowish red colour, and highly caustic.

The red mass left in the retort is sulphate of potash, combined with the basis of the copperas. They are separated by pulverization, boiling, and repeated filtering, and the red oxide is colcothar, trip, or rouge.

Foreign manufacturers make aquafortis, by distilling rough saltpetre with clays and boles, instead of copperas. The result is inferior, and the residuum, being large, is used as red sand, for ornamental purposes.

The next of these compounds is called the *deutoxide of nitrogen*, or *nitric oxide*, and consists of 1 volume of oxygen, and 1 of nitrogen. That is, in regard to the diluter, it is twice the strength of the prot-oxide, and 4 times greater than air, being 1 to 1, instead of 1 to 2, and 1 to 4. It is, however, much lighter than the last, though heavier than air, 100 cubic inches weighing 31·769 grains, while 100 of air weighs but 30·519 grains.

It is made by applying a gentle heat to a mixture of copper clippings, or chips with nitric acid, diluted with seven times its bulk of water. And these are the constituents of the mixture which compose the fluid in galvanic troughs. A mixture of it, and hydrogen, burn with a clear green flame, and they detonate when passed through an ignited tube. It absorbs oxygen from the atmosphere, and forms nitrous acid, therefore cannot be respired. It extinguishes a taper and sulphur; but phosphorus burns in it rapidly.

The fourth of these compounds of nitrogen and oxygen, is *nitrous acid*, which consists of 3 oxygen and 2 nitrogen per volume, and 100 cubic inches weigh 80·48 grains.

The fifth union of nitrogen and oxygen consists of 5 volumes of oxygen and 2 of nitrogen, being 10 times stronger than air. 100 cubic inches weigh 114·37 grains, that is, its specific gravity to air at 30·519, is 3·75 to 1 nearly. It is made by pouring half the weight of sulphuric acid upon refined saltpetre, well pulverized, and exposing the mixture in a retort in a furnace. It produces the gas even without heat, but a moderate heat soon evolves all the gas, which condenses into the receiver, as *nitric acid*. Sound luting, and caution against explosion and breathing the gas, is necessary. It is concentrated by heating it in a glass retort, and allowing the diluting nitrous gas to escape, and to separate it from the sulphuric acid; it is sometimes distilled a second time.

The equivalent numbers of these 5 compounds of oxygen and nitrogen are as under, in gaseous forms:

| | | | |
|---|---|---|---|
| Air .......... | 1 ox. | 8 + 4 N. 56 | = 64. |
| Nitrous oxide, | 1 ox. | 8 + 2 N. 28 | = 36. |
| Nitric oxide.. | 1 ox. | 8 + 1 N. 14 | = 22. |
| Nitrous acid.. | 3 ox. | 24 + 2 N. 14 | = 38. |
| Nitric acid .. | 5 ox. | 40 + 2 N. 14 | = 54. |

Nitric acid, as liquid, has a specific gravity of 1·5 to water 1, but it varies from 1·583 to nearly the density of water, and the quantity of real acid, when specific gravity is 1·5, is about three quarters. Its adulterations with sulphuric or muriatic acids are detected by nitrate of lead.

Nitrogen combines only with one solid, carbon 1 and 2, and forms cyanogen, which, with hydrogen, is prussic acid.

NITROUS ETHER, or *Sweet Spirit of Nitre*, is made by putting three pints of alcohol into a bottle placed in cold water, and adding by degrees one pint of nitrous acid. Let it stand for seven days, and then distil it at a moderate heat into a cooled receiver. It is diuretic and anti-febrile, taken in half a tea-spoonful or tea-spoonful in a glass of water, or barley-water.

NOOTH'S APPARATUS; this is used to impregnate water with gases. Three glass vessels are connected over one another. The lower contains the gas-making materials, with an orifice closed to admit more. The second is filled with water, and a valve and the gas, rising into it, soon fills both vessels with impregnated water. Woolfe, Pepys, Knight, and Hamilton, have varied and improved it.

NUTMEG-TREE, a native of the Molucca, or Spice Islands, principally confined to that group denominated the islands of Banda, lying in lat. 4° 30′ south. It bears both blossom and fruit, at all seasons of the year, and assists, with other aromatic trees and shrubs, to form that atmosphere of fragrance, in the upper regions of the air, in which the natives believe the birds of paradise perpetually float.

While the Dutch remained possessors of the Spice Islands, the quantity of nutmegs and mace exported from their nutmeg-grounds, circumscribed as they were, was enormous; 250,000 lbs. annually used to be vended in Europe, and nearly half that amount in the East Indies. Of *mace*, the average has been 90,000 lbs. sold in Europe, and 10,000 lbs. in the East Indies.

When the islands were taken by the British, in 1796, the importations of the East India Company into England alone, in the two years following the capture, were, of nutmegs, 129,732 lbs., and of mace 286,000 lbs. When the crops of spice were superabundant, and the price likely to be reduced, the Dutch destroyed immense quantities of the fruit. A Hollander informed Sir Wm. Temple, that, at one time, he saw three piles of nutmegs burnt, each of which was larger than a church could hold.

M. Poivre has the credit of introducing this valuable plant into the isles of France and Bourbon, in 1772, together with the clove. But, in 1796, the British took possession of the Molucca Isles, and, two years afterwards, planted the nutmeg at Bencoolen, in Sumatra, where it has grown with the greatest luxuriance; so that, in five years, the trees arrived at from 10 to 14 feet in height, and, in October and November, 1802, 247 trees, out of about 600, blossomed. About half of these were male, and the rest female. A second importation was made, and 22,000 nutmeg-plants, from Amboyna, were planted, which, in a few years, yielded 200,000 lbs. weight of nutmegs, and 50,000 lbs. of mace.

The Dutch were totally ignorant of the diœcious nature of the trees, and of the cause of sterility in so many of them. Where the trees are very abundant, this is a matter of comparatively trifling importance; but where there were but few plants, it is of essential consequence that the female flowers should be fertilized by the male. Hubert, in the Isle of France, ascertaining that one male plant is sufficient for a hundred females, he resolved upon grafting the seedling stock of all his plantations in that proportion, in the second year of their growth: by this means, there are no superfluous trees, and they come sooner into bearing.

The nutmeg was introduced in the West Indian colonies, about 1800, first, to the island of St. Vincent, from Cayenne. The three trees which were originally imported, have borne fruit for many years, and have attained the height of 20 feet, with a trunk 8 or 9 in. in diameter. The plants at Trinidad flourish best in the rainy season, and even when moderate showers fall, they require constant watering; although a soil saturated with moisture is injurious. Female flowers, which reached perfection on the 20th of June, became ripe fruit from the 6th to the 12th of February following. The trees are almost always in flower, but fruit is most abundant in April, May, and June, and the seed vegetates in six weeks.

In the Moluccas, the gathering of the fruit takes place at three periods, in July or August, when the nutmegs are most abundant, but the mace thinner than in smaller fruits, gathered in November; the third harvest is in March or April, when the nuts, as well as the mace, are in the greatest perfection. The outer pulpy coat is removed, and, afterwards, the mace, with a knife. The nuts are placed over a slow fire, when the shell becomes very brittle, and the seeds, or nutmegs, drop out; these are then soaked in sea-water, and impregnated with lime, a process which answers the double purpose of securing the seeds from the attack of insects, and of destroying their vegetating property. It further prevents the volatilization of the aroma. The mace is simply dried in the sun, and then sprinkled with salt-water, after which it is fit for exportation.

The colour, when fresh, is a brilliant scarlet. When dry, it becomes much more horny, of a yellow-brown colour, and very brittle. The shell very hard, rugged dark-brown, glossy, about half a line thick, pale, and smooth within. This immediately envelopes the seed, or nutmeg, which is of an oval or elliptical form, pale brown, quite smooth, when first deprived of its shell, but soon becomes shrivelled, so as to have irregular, vertical lines, or furrows on its surface. Its outside very thin; its inner substance or albumen is firm, but fleshy, whitish, but so traversed with red-brown veins, which abound in oil, as to appear beautifully marbled. Near the base of the albumen, and imbedded in a cavity in its substance, is situated the embryo, which is large, fleshy, yellowish-white, rounded below, where is the radicle; its catyledons, of two, large, somewhat foliaceous, plicate lobes, in the centre of which is seen the plumule.

The whole fruit, preserved in sugar, is brought to table, in India, with the dessert, but not till after the acrid principle has been, in a great measure, removed, by repeated washings.

An essential oil is obtained from the nutmeg and the mace, by distillation, and a less volatile one by expression.—*Curtis's Bot. Mag.*

NUX VOMICA, *(Strychnos)*.—The ripe pulp is eatable in small quantity; but *nux vomica* is horny, requires rasping or roasting, very bitter, emetic, and poisonous to most animals. They act as an excitant on the nervous system, and produce locked-jaw. They are used in paralysis, and in chronic diarrhœa and chronic dysentery. Brewers use them to give an intoxicating effect to their compounds.

*For Alcoholic Extract of Nux Vomica.*—Digest rasped nux vomica in alcohol 1 lb. at 40 deg. Beaumé, in a cool place; strain, and evaporate to an extract.

OAK, *(quercus)* is among the most useful productions of temperate climates, with the exception of a few on the mountainous parts of the equatorial regions. More than eighty species are known, of which one half inhabit North America, either within the territory of the United States, or on the mountains of Mexico. The white oak *(Q. alba)* is one of the most valuable. It attains the height of seventy or eighty feet, with a trunk six or seven in diameter. It is usual, after stripping the oak of its bark, to leave it standing for three or four years before it is cut for use. This species, and the *stillata*, are the species which furnish staves for casks, of which the consumption is immense. White oak timber is imported in immense quantities, from the ports of the Northern and Middle States; and that brought from Quebec is procured chiefly on the borders of lake Champlain, in the states of New York and Vermont. The *Q. macrocarpa* is remarkable for the large size of the leaves and acorns, but the wood is of little value.—The *Q. lyrata* is exclusively confined to wet swamps. The acorns are nearly covered by the cups. The timber is large and highly esteemed.

The live oak *(Q. virens)* is a tree of the very first importance. The leaves are evergreen, coriaceous, and entire. It does not usually attain greater height than forty or forty-five feet, with a trunk one or two in diameter, but the wide and branching summit furnishes knees of vessels. The wood is used for the naves and felloes of heavy wheels, for which purposes it is far superior to the white oak, as well as for screws and the cogs of mill-wheels. The bark, too, is excellent for tanning. The black or quercitron oak *(Q. tinctoria)* is a large tree, found throughout the United States south of latitude 43°, and abundant in the Middle States. It is recognised by the yellow stain which it gives to the saliva on being chewed. The wood is reddish and coarse-grained, and is frequently substituted for white oak in building. It furnishes a large proportion of the red oak staves which are exported to the West Indies, and the bark is extensively employed in tanning. From the cellular integument *quercitron* is obtained—an article extensively employed in dyeing wool, silk, and paper-hangings, and which forms an important article of export from Philadelphia. The cork oak *(Q. suber)*, furnishes the cork of commerce, which substance is the outer, thick, fungous covering of the bark, and is detached, at intervals of ten or twelve years, for as many as twelve or fifteen times, but, after the fifth or sixth, the quality degenerates. If not removed after a certain period, it splits and falls off, and is replaced by a new growth beneath. In some countries, where cork is abundant, the inhabitants use it for lining or covering their houses. When burnt in close vessels, a black powder is obtained, known under the name of *Spanish black*. The cork oak is cultivated in Spain, Portugal, and the south of France. It is best adapted to a dry, sandy, mountainous soil, and is never found in limestone districts.

To ascertain the strength of New Forest oak, a seasoned stick of timber was selected in April. From about midway between the centre and circumference of the tree, and beginning at about four feet from the ground end, a piece of very good and perfectly sound timber was cut, and reduced to the dimensions of five inches square, and eleven feet long. It was laid across two uprights; and a rough scale-like platform to contain the weight, formed of a very large plank, was suspended from the centre, by a strong timber chain. Upon this platform, piece after piece was laid of hard Purbeck stone, until it became evident that there was sufficient to effect the fracture, and in a few seconds the whole fell to the ground. The stones employed were then weighed, and the weight of the platform and chain being added, it was found that the aggregate weight by which the object had been obtained, was 9,061 pounds, or 4 tons, 3 quarters, and 17 pounds.

*Oak bark*, in the inner cortical of young trees, contains 77 of 111 of the tannin principle. The cellular, or middle, only 19 of 43, and the external part scarcely any tannin. In spring, the tannin is more than in winter.

OAKUM, is the substance into which old ropes are reduced when they are untwisted, loosened, and drawn asunder. It is principally used in calking the seams, tree-nails, and bends of a ship, for stopping or preventing leaks.

OAR; a long piece of timber, flat at one end, and round or square at the other, used to make a vessel advance upon the water. The flat part, which is dipped into the water, is called the *blade*, and that which is within the board is termed the *loom*, whose extremity, being small enough to be grasped by the rowers, is called the *handle*.

OAT *(avena)*, a grass, bearing a few large flowers, which are disposed in a loose panicle; and there is another species, the *naked oat*, differing in not having the seed adherent to the floral valves. The meal is nutritious, and, in some countries, forms an important article of food for men and horses. Beer is made from it, and it is distilled to procure spirits.

OCHRE.—An earthy substance, with which some metallic oxide is mixed, commonly of a yellow, brown, or red colour. The colour of such specimens as are dark may be rendered of a brighter red by calcination. The ferruginous ochres, which are most common, appear to have been produced by the decomposition of the martial pyrites, which consist of sulphur and iron.

OCHRE, (YELLOW), with size is extensively and advantageously employed in France, and Belgium, to colour the houses on the outside, conferring at once great cleanliness, and an air of taste and splendour not visible in English towns.

ODOMETER, is a portable contrivance of R. L. Edgworth, for measuring the rate of carriage-wheels, so as to discriminate fractions of miles and keep due reckoning for 5 or 100 miles.

ODOUROUS PLANTS lose much of their flavour in a silicious soil, and do not recover it by removal to a richer soil. Linnæus made a barren plant produce flowers, by mixing clay with the earth. Assafœtida and rhododendron vary their flavour and quality in various soils. Rhubarb in Turkey, and rhubarb in England, have very different products; while, in England, rhubarb in gravel is much superior to rhubarb in clay. Similar differences appear in the opium of Egypt, Asia Minor, and France; and in the senna of Arabia, and France. Dr. Harrison thinks that human susceptibility varies in different climates as well as the strength of drugs, since mineral preparations differ in effect in different countries.

ODORIFEROUS LAMP.—The peculiar property of spongy platina, of causing the union of hydrogen and oxygen with extreme facility, and at temperatures much below what is ordinarily required for the purpose, led to the examination into the chemical changes analogous to combustion, which other bodies could undergo by the same or similar means; and it was found that alcohol vapour in the open air, and under the influence of the prepared platina, became converted into acetic acid. The experiment then became nearly the same as that founded upon Sir H. Davy's discovery of the power of a heated platina wire, in continuing the combination of combustible bodies and supporters of combustion without flame; and, it ultimately gave rise to the formation of a lamp, which, containing alcohol, and prepared at the place of the wick with a piece of spongy platina, or, as Dobereiner calls it, suboxide of platina, or some other form of that metal, gradually converted the whole of the alcohol into acetic acid. The lamp in this form has been used for a night-lamp; it gives light enough to see the time by a watch held close to it, and if more light be required, a piece of amadou may be carefully inflamed at it, and then a light procured in the usual way. It is proposed to use Eau de Cologne in place of common spirit of wine, and then the fragrance diffused is very agreeable.

OFFAL, a term used by butchers, in regard to the parts of animals not vendible as flesh. Thus an ox of 800 lbs. has 250 lbs. offal; a sheep of 74 lbs. 24 lbs.; a lamb of 40 lbs. 12 lbs.; and a calf of 150 lbs. 35 lbs. offal. The offal is not wasted, since nearly every part is used in some product, or process.

OILS, FIXED, are products of animal matter, or of vegetables, or their seeds, and are produced by great power of pressure, often united to percussion in works called crushing-mills. They absorb oxygen, and become rancid, but with caustic alkalies they form soaps. With oxide of lead, when hot, they form plaisters; and they combine, with certain properties of vegetables, many curious preparations, being products of olive-oil, and various plants and roots. In China, nut-oil is drank in tea, instead of cream. Olive-oil has 0·915 sp. gr. and congeals at 38°. It is the butter and cheese of Italy, and hot climates, and its use is greatly on the increase in England.

*Oils, essential*, are produced by the distillation of their several substances. In alcohol they are the essences of perfumers, and, in water, they are the distilled waters of pharmacy. They rapidly combine with oxygen in the air, becoming resinous and vapid, and therefore should be well stopt. They are about 40 in number, and made from odorous flowers, resins, and roots. The lightest, oil of turpentine, has a sp. gr. 0·792, and sassafras 1·094, being the densest. When combined with ammonia, their fragrance is increased by its volatility, but alkalies diminish it by their inertness.

The lightest of the volatile, or distilled oils, oil of turpentine, has a sp. gr. 0·792. Sassafras, cinnamon, and cloves, are heavier than water. They evaporate, when pure, without stain on paper.

*Volatile oils* are made by putting anise, or caraway-seeds, juniper, and all-spice berries, flowers of lavender, or camomile, and in other cases parts of plants, into a still, with sufficient water to cover them, and receiving the oil in a large cooler.

Fixed oils are expressed oils, and do not boil under 600. Cruciform plants yield them in the seeds. The heaviest, palm-oil, is 0·968, and the lightest, neat's-foot, 0·8795.

*Fat oils* are olive, almond, rape, mustard, colza, plum, beech, hazel, eggs, &c. They make soap.

*Solid oils* are cocoa, palm, muscat, laurel, japan, myrtle, and bees'-wax, coco, &c. &c. They melt at low heats, as palm at 84°, and consist of stearine and elaine.

*Bituminous oils* are petroleum and mineral tallow, to which belong asphatum, mineral tar, and coals.

*Olive-oil* is prepared from ripe olives, gathered late in Autumn. The pulp is separated from the kernels, by passing them between stones ¾ of an inch asunder, and is then pressed in rush bags for the best oil. Two other qualities are afterwards obtained, by further pressure and fermenting. Its sp. gr. is 0·915, *i. e.* 35 gallons, in weight, are equal to 32 of water. On the skin it does not obstruct perspiration, but rather promotes it. So applied, once a day, it has been described as a prevention of the plague.

The sun-flower is cultivated in America, on a large scale, for the sake of table-oil. An acre yields 60 to 75 bushels, and every bushel a gallon. The cakes are fine food for the cattle.

Oils of almonds, linseed, and castor-seeds are prepared by simply bruising them, and then pressing out the oil. One lb. of almonds yields 5 oz., 1 of linseed 3 oz., 1 of castor-seeds 4 oz.

Oil of turpentine is distilled from 5 of turpentine and 4 of water. The residue is yellow rosin. It is rectified by distilling 10 of turpentine to 4 of water for half.

*Oil for chronometers.*—Having procured good olive-oil, put about one gallon into a cast-iron vessel capable of holding two gallons; place it over a slow, clear fire, keeping a thermometer suspended in it; and, when the temperature rises to 920°, check the heat, never allowing it to exceed 230°, nor descend below 212° for one hour; by which time the whole of the water and acetic acid will be evaporated. The oil is then exposed to a temperature of 30° to 36° for two or three days. By this operation, a considerable portion is congealed; and while in this state, pour the whole on a muslin filter, to allow the fluid portion to run through; the solid, when re-dissolved, may be used for common purposes. Lastly, the fluid portion must be filtered, once or more, through newly-prepared animal charcoal, grossly powdered, or rather broken, and placed on bibulous paper in a wire-frame, within a funnel: by which operation rancidity (if any be present) is entirely removed, and the oil is rendered perfectly bright and colourless.

Oil, for delicate machinery, should be purified from its stearine, or fatty matter, which is effected by gradually boiling it with eight times its weight of alcohol. When cold, the stearine separates in a precipitate, and the liquid is to be evaporated to a fifth, which is pure elaine, or oil, without any chemical action or odour.

Oils in painting afterwards fatten and do not dry, owing either to want of combination in the pigment, or to the oil not being old enough. Olive-oil, for example, will not dry, and all vary in this defect. Keeping, and the use of some drying substances, are the best remedies. Oils are adopted because they give an equal surface and a subsequent body.

*Drying oils*, by boiling, or sometimes by setting on fire, by which they cease to stain paper, are linseed, walnut, hemp, poppy, castor, croton, grapeseed, nightshade, tobacco, henbane, sunflower, and cress.

Drying oils are best prepared by boiling a gallon of linseed-oil with 1½ lb. of red lead, and leaving it to stand till the lead has subsided. Other materials effect the same purpose, as white vitriol, sugar of lead, gum mastic, &c. where long boiling is inconvenient.

*Or*, take half a gallon of linseed-oil, and slowly boil it with 6 oz. of litharge, and 1½ of white vitriol, till no more scum arises. Let it cool and settle, and then pour off the clear into small vessels, and in ten days it will be fit for use.

*Or*, suspending in boiling oil a bag of litharge and white vitriol for 4 or 5 hours.

*Or*, well stir a ℔. of white lead with a gallon of linseed-oil, and leave it to settle for 8 or 10 days.

The following, according to the excellent work of Tingry, are some of the methods employed to give to fat oils a drying quality. Take of nut-oil, or linseed-oil, 8 ℔s.; white lead slightly calcined; sugar of lead, also calcined; white vitriol; of each 1 oz. Litharge, 12 oz., a head of garlic, or a small onion. When these are pulverized, mix them with the garlic and oil over a fire capable of maintaining the oil in a slight state of ebullition: continue it till the oil ceases to throw up scum, assumes a reddish colour, and the garlic, or onion, becomes brown. A pellicle indicates that the operation is completed. Take the vessel from the fire, and the pellicle, precipated by rest, will carry with it the unctuous parts. When the oil becomes clear, separate it from the deposit, and put it into wide-mouthed bottles, where it will completely clarify itself.

*Or*, Take of litharge $1\frac{1}{4}$ oz., white vitriol $\frac{3}{8}$ oz., linseed, or nut oil, 16 oz. To be conducted as the preceding.

In all cases, where preparations of lead are employed for freeing oils from greasy principles, the mixture should not be stirred. It is snfficient to leave the mixture over a gentle fire, capable of producing slight ebullition. The garlic merely indicates the moment when the aqueous part is evaporated.

*Drying oil* is employed by those who paint pictures, and it enters into the composition of varnishes. It serves itself also as varnish, either employed alone, or diluted with oil of turpentine.

For house painting, it is advantageous to use, for the last coating, *resinous drying oil*, as a varnish. It is prepared as follows:—Take 10 ℔s. of drying nut-oil, if the paint be designed for external surfaces, or 10 ℔s. of drying linseed-oil, if for internal. Yellow resin 3 ℔s., common turpentine 6 oz. Melt the resin, to which add the turpentine, and lastly, the oil, so as not to coagulate the resin; leave the varnish at rest, by which means it will often deposit portions of resin and other impurities; preserve it in wide-mouthed bottles. It must be used fresh: when suffered to grow old, it deposits some of its resin. If this resinous oil become too thick, dilute it with a little oil of turpentine, or with oil of poppy, if intended for articles sheltered from the sun.

The drying quality may be communicated to oil by maintaining a slight ebullition, and to each ℔. add 3 oz. of litharge reduced to fine powder. *Or*, it may be given to linseed-oil, and its colour much improved, *without boiling*, by mixing about 1 ℔. of white lead with a gallon of oil, and letting it stand a week or two, till the lead and the feculent parts of the oil have subsided.

When long-continued cold of winter gives to snow a dry consistence, take linseed-oil, nut-oil, or oil of poppy, and mix it with snow, kneading the mixture in a bason with a wooden spatula, or in a mortar with a pestle. Form it into a solid mass, and place it in an earthen, a glass, or a porcelain vessel, exposed to the cold; and, on thawing, the snow will dissolve into water, which will separate itself from the oil, with the impurities of which, the dissolved water will be charged.

After all, Whittock says, the most simple process for preparing drying oil is to boil it for a considerable time without any addition.

*Drying oil for Printers' Ink*, is made by boiling linseed-oil for eight hours in a large iron pot, and adding to it bits of toasted bread, to absorb the water contained in the oil. Leave it at rest till next day, and then expose it other eight hours to the same heat, or till it has acquired the necessary consistence. When this prepared oil retains any unctuosity, it fills the eye of the letter, runs upon the paper, and communicates to it a semi-transparency of a yellow colour, as in works printed with bad ink.

This process ought to be carefully performed in the open air: for expressed oil, to boil, requires about 600° of Fahrenheit.

To make it into ink add lamp-black, worked up with a mixture of oil of turpentine and common turpentine.

Oil Mills, or Pression Mills, are moved by horse, or water power, in Holland by wind, and in England often by steam. The object is to unite weight of pressure with percussion, and therefore obtain oil from seeds. The principle is that of the pile engine, the falling with acceleration of a heavy loaded beam on a bag of seed, so placed as that its oil will exude into receptacles beneath. A wheel called a walloper, provided with wipers, or projections, is turned by the spur and treadle, and the wipers catch and lift the beams, or pestles, which being unattached by the rotation of the wheel fall with force on the seed, which has usually been rolled and expressed previously. The oil paste, or cakes, left after pressing, is excellent food for cattle. In spite of our general ingenuity, the French vegetable oils produce the whitest and clearest light known, equal to the best carburetted hydrogen gas, and worthy of the emulation of our British manufacturers.

The quantities of volatile oil, obtained from different vegetables, are:—

| | | |
|---|---|---|
| Aniseed | 1 pound | 2 drachms |
| Assafœtida | 4 ounces | 1 drachm |
| Cajaput seeds | 1 pound | 15 grains |
| Camomile flowers, common | 1 pound | ½ drachm |
| Caraway seeds | 4 pounds | 2 ounces |
| Cardamum seeds | 1 ounce | 1 scruple |
| Carrot seeds | 2 pounds | 1½ drachm |
| Cinnamon | 1 pound | 1 drachm |
| Cloves | 1 pound | 1½ ounce |
| Copaiba balsam | 1 pound | 6 ounces |
| Cummin seed | 1 pound | 5 drachms |
| Dill seed | 4 pounds | 2 ounces |
| Juniper berries | 8 pounds | 3 ounces |
| Lavender, in flower, fresh | 48 pounds | 12 ounces |
| Mace | 1 pound | 5 drachms |
| Marjoram, in flower, fresh | 85 pounds | 3¾ ounces |
| Nutmegs | 1 pound | 1 ounce |
| Roses | 1 cwt. | 1 ounce |
| Rosemary, in flower | 1 cwt. | 8 ounces |
| Sage leaves | 34 pounds | 1½ ounce |
| Sassafras wood | 6 pounds | 1¾ ounces |
| Savin bark | 2 pounds | 5 ounces |
| Thyme, in flower, fresh | 2 cwt. | 5½ ounces |

According to experiments, the following species of plants yield per cent. of oil :—

| | |
|---|---|
| Filberts | 60 |
| Garden cress | 56 to 58 |
| Olive | 50 |
| Walnut | 50 |
| Poppy | 47 to 50 |
| Almond | 46 |
| Navew | 39 |
| White Mustard | 36 |
| Tobacco seed | 32 to 36 |
| Kernels of plums | 33 |
| Winter rape | 33 |
| Summer rape | 30 |
| Woad | 30 |
| Carnelina | 28 |
| Hemp seed | 25 |
| Fir | 24 |
| Linseed | 22 |
| Black mustard | 18 |
| Heliotrope | 15 |
| Beech masts | 12 to 16 |
| Grape stones | 10 to 11 |

—*Timbs' Arcana of Science.*

OIL AND HARTSHORN.—Mix 2 drs. of solution of carbonate of ammonia with 1 oz. of olive-oil.—*Or*, to 1 oz. of best olive-oil add 3 drops of caustic ammonia.

OLIBANUM, is an oriental product, used chiefly as a perfume. Its oil resembles oil of lemons, and it burns with fragrance.

OLEFIANT GAS.—Distil, by an oil lamp, one volume of alcohol with two of sulphuric acid, mixed gradually, and then agitate in a solution of quick-lime.

ONIONS, a valuable, nutritive, and wholesome vegetable. An acre, highly manured, has yielded three tons, but two tons is the ordinary produce; about 1-11th that of potatoes, and four times that of wheat.

*Onion Soup*, made with grits, or oatmeal, and milk, is highly restorative. It is considered peculiarly grateful, and gently stimulating to the stomach.

*To prevent the sprouting of Store Onions.*—Apply a heated iron for a few seconds to the nozzle of the onion whence the roots protrude.

OOLITE, is a thick formation of calcareous stone, lying on the lias strata.

OPIUM, is the inspissated juice of the poppy, sometimes flowing from wounded seed-vessels, and more generally expressed from them. It arrives from Turkey in flat pieces, with a sp. gr. of 1·336. It is dissolved in water, or alcohol, and the latter preserves greater strength. Latterly, it has been decomposed, and its essence concentrated in an alkali, called morphine, or morphia, soluble in alcohol, with alkaline properties, and consisting of 7·2 carbon; 5·57 nitr.; 7·61 hydr.; and 14·34 oxy. It is also soluble in olive-oil and acids. Turkey opium contains 3 times as much as East Indian. It is an article of great commerce in Asia, and no less than 40,000 lbs. are imported every year in London. No product has more facilitated the enterprizes of quacks than opium, and we have 20 or 30 nostrums of which it is the basis, under the name of cough-drops, elixirs, balsams, besides the famous black drop, which is thrice the strength of laudanum.

*Opium Pills.* Opium 1, soap 7, allspice 2, to allay irritation.

*Tincture of Opium.*—In two pints of tincture of salt of tartar (made by pouring it on 6 oz. of subcarbonate of potash, while hot from calcination), infuse 2 oz. of opium, 1 oz. of crocus (saffron) and 1 dr. of cinnamon, cloves, mace, aloes, and nutmegs.

OPODELDOC *(Soap liniment).*—In

1 ℔. of spirit of rosemary mix 1 oz. of camphor, and 3 oz. of Castile soap.

*Or, (Compound).* In 2 ℔s. of alcohol mix half an oz. of oil of rosemary, 2 oz. of camphor, and 4 of Castile soap.

ORANGE, *(Citrus Aurantium)* a very grateful fruit for allaying thirst, especially in fevers. They are brought to England from Spain, and the Azores, in immense quantities. The Seville variety is more acid and bitter, and the outer rind is used in medicine as a stomachic, to flavour other bitters. The small unripe Curaçoa are used in flavouring the rich cordial of that name.

*Orange Trees.*—At Mr. Pugh's villa, at Rouen, is a collection of large orange-trees, some of them with their boxes above seventeen feet high, and several centuries old. There are a hundred, set out at regular distances, in an enclosure laid with gravel. In winter the trees are kept in a barn-like building. These 100 trees, in 1823, produced 1,400 ℔s. of blossoms, which sell, on an average of years, at 2*s.* 4*d.* per ℔. to apothecaries and confectioners, for orange-water.

ORES, are the various natural forms in which the substances are found, which, by treatment, constitute metals. They are very numerous.

| | | |
|---|---|---|
| Antimony | 14 | *Ores.* |
| Arsenic | 10 | |
| Bismuth | 5 | |
| Cobalt | 12 | |
| Copper | 31 | |

And so for others.

Ores, with reference to their origin, are the compounds generated by the silent electrical action of separated but adjacent rocks; and they consist of the essential and volatile parts of the rock combined with oxygen and nitrogen, the agents of electrical action. The matter of the rock, which is the base of the ore and metal, creates the differences between the electrical products in the ore and in what we call the metal, when the ore is de-oxydated, and has been freed from foreign substances called mineralizers, which arise themselves from common principles in all rocks, acted upon by the electrical interchange or mechanical restoration.

The gross ignorance which hitherto has prevailed, as to the cause and *modus operandi* of electricity, and the confused theories and superstitions about the generation of metals, having misdirected observations, it is difficult to assemble facts which have relevancy to real knowledge. The following is, however, a summary of *some* of the ores and their adjuncts:

Antimony.—1. Metal 75, sulphur 25.—2. Metal 24, lead 43, copper 13, iron 2, sulphur 17.—3. Metal and arsenic 62, nickel 23, sulphur 14.—4. Metal 68, sulphur 20.—5. Oxides of metal 33, of iron 4·0, of sulphur 4. Hence, wherever antimony is generated, *sulphur* is a collateral product.

Arsenic.—1. Metal 43, iron 35, sulphur 20.—2. Metal 69, sulphur 31.—3. Metal 62, sulphur 38.

Again *sulphur* is an adjunct, and every electrician is aware of the sulphurous odour of his experiments, while in a stroke of lightning the sulphureous smell is always suffocating. The double product is, however, a fact which will instruct us in due time, and assist inquiry beyond present suspicion.

Bismuth.—1. Metal 43, lead 24, copper 12, sulphur 12, nickel 2, gold 1.—2. Metal 60, sulphur 40.—3. Metal 47, copper 35, sulphur 13.–4. Oxides of the metal 86, of iron 5, with carbonic acid 4, and water 3.

Such different products prove the variety of components in the rocks, and the absence of sulphur in the last is supplied by bodies likely to be its constituents. The ochreous formation was, perhaps, not old enough.

Copper.—1. Oxide of metal, lime 43, silica 28·57.—2. Oxide 55, 33 silica, 12 water.—3. Metal 56, carbonic acid 25, oxygen 13·5, water 6·5.—4. Metal 58, car. acid 18, oxygen 12·5, water 11·5—5. Metal 40, silica 26, water 17, oxygen 10, car. acid 7.—6. Metal 38, silica 29, water 22, oxygen 8, sulphate of iron 3.—7. Oxide of the metal 32, sulp. acid 32, water 36.—8. Oxide 68·13, phosphoric acid 31.—9. Metal 41, arsenic 24, iron 22·5, sulphur 10.—10. Metal 39, sulphur 26, antimony 19·5, iron 7·5.—11. Metal 78, sulphur 18·5, iron and silica 3.—12. Metal 69·5, sulphur 19, iron 7·5, oxygen 4.

There are 18 or 20 other ores of copper, but we still find *sulphur* in the regular ores.

Iron Ores, except in pyrites, have no sulphur, but these have 52·5 sulphur to 47·5 metal, and 53·6 sulphur to 46·4 metal. Lead is generally combined with sulphur as 5 metal to 1 sulphur.

The subject might be pursued, but it would appear that sulphur, in ordinary cases, is the general adjunct. In silver, sulphur is a fifth, and in zinc a third of most of the ores. In a gold ore, which yielded 41·5 of gold in 1,000, lead was a 4th, quartz 437, tellurium a 7th, and sulphur but 14. There were also some silver and copper, and 92 oxide of manganese.

The subject is complicated, but its importance demands careful and rational investigation, which it could not obtain while radical mistakes existed about the nature of electrical action.

Viewing metals as chemical and electro-mechanical products in long time, it appears not hopeless to imitate nature in this respect as well as in many others. That metals grow has long been the opinion of chemists, miners, and mineralogists, but the agency has hitherto been obscured by false and absurd theories.

The separation and analysis are works of great elaboration.

The metals which form oxides with neutral salifiable bases are:—

PLATINUM, precipitated by muriate of ammonia.

GOLD, by sulphate of iron, and nitrate of mercury.

SILVER, by salt.

MERCURY, by salt.

COPPER, by iron.

IRON, by heat.

TIN, by corrosive sublimate.

LEAD, by sulphate of soda.

ZINC, by carbonate of alkalies.

COBALT, by ditto.

BISMUTH, by water.

PALLADIUM, by prussiate of mercury.

NICKEL, by sulphate of potash.

CADMIUM, by zinc.

ANTIMONY, by zinc.

MANGANESE, by tartrate of potash.

Arsenic, chronium, and molybdenum, by nitrate of lead; tungsten, by muriate of lime; columbian, rhodium, and iridium, by zinc. By these, and by sundry treatments in obtaining solutions, the separation is effected, when the ores are blended in twos, threes, or fours.—*See* ANALYSIS, the several metals, &c.

**ORNAMENTAL GARDENING**, is a subject of great extent, as one of taste and luxury, and includes the formation of parks, the grouping of plantations, &c.; but, in this place, we shall treat only of such shrubs and flowers as confer beauty on ordinary gardens, on cottage-fronts, &c. without interfering with solid produce.

The species and varieties are immense, but those which, between lat. 50 and 54, may be cultivated without a greenhouse or hot-house, are the following:

| SHRUBS. | BLOSSOMS IN | METHOD OF PROPAGATION. |
|---|---|---|
| 1 Althea Frutex .... | August & Sept. .. | Cuttings, layers, and seed |
| 2 Box, the tree .... | April & May .... | Seed only |
| – Edging ditto ...... | Ditto ............ | Parting the roots |
| 3 Clematis .......... | July & August .. | Ditto, and seeds |
| 4 Holly ............ | April ............ | Seeds only |
| 5 Labernum ........ | May & June ..... | Ditto |
| 6 Guilder Rose...... | Ditto ............ | Seeds, suckers, and layers |
| 7 Honeysuckle...... | May to July -.... | Seeds, suckers, cuttings and layers |
| 8 Jasmine, several varieties ........ | July to Sept. .... | Cuttings and suckers |
| 9 Laurel ............ | May ............. | Layers, and parting the roots |
| 10 Lilacs ............ | Ditto ............ | Layers, and parting the stools |
| 11 Privet ............ | June & July .... | Layers, seed, and parting roots |
| 12 Rose ............. | June to October . | Suckers and layers |
| 13 Syringa .......... | May & June ..... | Seeds and layers |
| 14 Southernwood .... | June ............ | Parting the roots |

When they are to be propagated, by suckers, cuttings, or layers, those operations should be performed in the autumn or winter months. When raised from seeds, the general time of sowing is in March or April. The tree box and the holly make beautiful evergreen hedges. The privet is also very useful for that purpose, but must be kept clipped very close. The clematis, jasmines, and honeysuckles are climbing plants; and may be trained over door-ways, trellis-work, on buildings, or on fences. The dwarf, or edging box, forms a superior edging for walks. The laurel, the lilac, the guilder-rose, and the syringa, may be usefully and ornamentally grown, to protect the garden from north and east winds. Of roses, the *moss* is generally considered the most beautiful; the *Provence*, *white and red*, and the *damask*, are also favourites. As an ornament there is nothing to excel the *China rose*, since, in favourable situations, it will blossom eight months with a profusion of flowers. It is very hardy, and may be propagated by cuttings, as well as layers and suckers, and it requires training and pruning.

Herbaceous flowers are annual, biennial, and perennial, and these again are fibrous, tuberous, or bulbous.

| ANNUALS. | TIME OF SOWING. | OBSERVATIONS. | FLOWERING. |
|---|---|---|---|
| 1 Adonis, the scarlet ............ | Mar. to May. | Does not transplant well.. | August till the frost comes |
| 2 Chinaster....... | Mar. & April | Transplants well ......... | Ditto |
| 3 Candytuft ...... | March ....... | Ditto ...................... | June and July |
| 4 Centuary ....... | Ditto ........ | Ditto ...................... | July and August |
| 5 Convolvolus .... | Do. & April.. | Ditto a climbing plant .... | June to August |
| 6 Convolvolus major.......... | April ........ | Ditto, best sown in pots & then transplanted .... | July to Sept. |
| 7 Devil in a bush . | Ditto ........ | Does not transplant well.. | June to Sept. |
| 8 Larkspur ....... | Mar. to June. | Ditto ...................... | June to Sept. according to the diff. sowings |
| 9 Lavatera ....... | March ....... | Ditto ...................... | July to Sept. |
| 10 Lupines ........ | Mar. to May . | Ditto ...................... | June to Sept. |
| 11 Marygold ...... | March ....... | Transplants well ......... | Ditto |
| 12 Mignonette .... | Mar. to June. | Does not transplant well.. | June till frosty |
| 13 Nasturtiums .... | Mar. to May . | Transplants well, is a climbing plant | July to October |
| 14 Sweet Peas .... | Nov. to May. | Does not transplant well, are climbing plants | June to August |
| 15 Poppy, ditto .... | Mar. & April. | Does not transplant well.. | June and July |
| 16 Rose Campion .. | March ...... | Ditto ...................... | July and August |
| 17 Stocks .......... | Ditto ........ | Transplants well ......... | July to October |
| 18 Xeranthemum.. | Ditto ........ | Ditto ...................... | July and August |
| 19 Zinnia .......... | April ........ | Does not transplant well .. | June to Nov. |

2, 3, 4, 11, and 17 should be transplanted at about from nine to twelve inches apart. 5, 6, 13, and 14 are climbing plants, and must be supported. The rest must be thinned out to suitable distances, never leaving them too thick. The ten-week stocks will be much forwarded by sowing them on heat in the month of March.—*Tender Annuals* may be raised by sowing them in pots, and keeping them in a sunny window when young; gradually innuring them to the open air before transplanting. The *Amaranthis*, *Balsam*, *Cockscomb*, *Egg-Plant*.—They should be sown early in April, potting them out singly, when about two inches high, or pricking them out on a gentle heat, and protecting them by covering them till the beginning of June, when they may be transplanted into a warm sunny situation. They should be taken up with balls of earth about their roots when transplanted. Some should be potted, and placed in windows. Balsams should be so planted that they may be occasionally covered from heavy storms of rain, or the too great heat of the sun.

*Hardy Biennials*,—sown one year, comes to perfection the succeeding year. In the various tribes of flowers and vegetables there are many of these.

| BIENNIALS. | BLOSSOMS IN | METHOD OF PROPAGATION. |
|---|---|---|
| 1 Carnation, Pink, and Piccatee .... | June and July ... | Seed, layers, slips, & *pipings* |
| 2 China Hollyhock.. | July to Septem. . | Seed, sown in July |
| 3 Indian Pink ...... | July ............. | Seed, and parting the roots |
| 4 Rocket, scarlet ... | May to August .. | Cuttings, and parting the roots |
| 5 Scabious, sweet ... | August and Sept. | Seed sown in April |
| 6 Stocks | | |
| Brompton........ | May to July ..... | Ditto, in July |
| Twickenham .... | Ditto ............ | Ditto |
| Queen ........... | Ditto ............ | Ditto |
| Giant ............ | Ditto ............ | Ditto |
| 7 Wallflowers ...... | April to June .... | Ditto, from November to April |
| 8 Canterbury bells . | August to Sept. .. | Ditto in March, and parting the roots |

- The carnation and piccatee should be sown on a slight heat in March. In May the plants should be pricked out, on a good open spot of ground, about six inches apart. About Michaelmas take them up, and replant them about a foot apart, to blossom the succeeding summer; *save the seed from the choicest double flowers.* They are likewise propagated from layers, and slips, and sprigs, and the last is the most common way of propagating pinks. Hollyhocks should be planted at least 18 inches apart. 3, 4, and 5 may be planted about a foot apart. No. 6, should be planted out in sheltered but not shaded places, early in September. Some of them may be planted in a bed, where they may be hooped over, and covered in severe frost. They may be removed with balls of earth to them, and planted elsewhere in April. Wallflowers are sometimes destroyed by severe winters, but they are very hardy when young, and the seeds should be sown in November or January.

By PERENNIAL is meant *lasting*-rooted flowers or plants, that is, whose roots last many years. Many of these are propagated by parting of the roots, though sometimes by slips, cuttings, and layers, as the quickest way of providing a stock of plants. But seedling plants, of every description, make the finest plants.

| PERENNIALS. | BLOSSOMS IN | METHOD OF PROPAGATION. |
|---|---|---|
| 1 Auricula | April | Seeds and offsets |
| 2 Campaniela | July and Aug. | Parting the roots in autumn and spring |
| 3 Chrysanthemum | Oct. to Dec. | Ditto, cuttings, and seeds |
| 4 Cinneria | May to Sept. | Suckers and seeds |
| 5 Cistus | Ditto | Seeds, and parting the roots |
| 6 Columbine | June & July | Ditto |
| 7 Corn Flag | July | Parting the roots |
| 8 Cowslips | April & May | Ditto and seeds |
| 9 Daisies | Ditto | Ditto |
| 10 Foxglove | June & July | Seeds sown in April |
| 11 Fraxinella | Ditto | Ditto |
| 12 Golden Rod | May & June | Parting the roots in winter |
| 13 Goldy Locks | Sept. & Oct. | Seeds sown on gentle heat in spring, and afterwards transplanted |
| 14 Hellebore | Feb. & March | Seeds and parting roots |
| 15 Hepatica | Ditto | Parting roots in spring |
| 16 Lobelia | July to October. | Seeds and suckers |
| 17 Lychoris | July and August. | Parting the roots in winter |
| 18 Madwort | March & April. | Seed, sown in March on gentle heat, and afterwards transplanted |
| 19 Pansy | April to Nov. | Seeds and parting the roots |
| 20 Pea, everlasting | July and August. | Seeds |
| 21 Polyanthus | March to May | Seeds and parting roots |
| 22 Peony | May and June | Parting the roots |
| 23 Primrose | March to May | Seeds and parting the roots |
| 24 Lily of the Valley. | May and June | Parting the roots in winter months |
| 25 Thrift | Ditto | Ditto |
| 26 Violets | March & April | Seed & parting roots or runners |

The auricula thrives best with an aspect to the east. Garden daisies, hepatica, cowslip, pansy, primrose, and polyanthus, lily of the valley, and violets, love shady places. The time of parting the roots is best in the winter months. April for sowing seeds.

By TUBEROUS roots is meant such roots as are fleshy, dividing into forked claws or tubers.

| TUBEROUS ROOTS. | BLOSSOMS IN | METHOD OF PROPAGATION. |
|---|---|---|
| 1 Anemonies | May to July | Offsets planted in November, December, and March |
| 2 Dahlia | Sept. and Oct. | Ditto, planted in April |
| 3 Ranunculas | May and June | Ditto, in Nov. Dec. and Mar. |

Bulbs are so called, because they form a kind of fruited-root, which, in general, has the quality of drying, and keeping a considerable time out of the ground in a dormant state.

| BULBOUS ROOTS. | BLOSSOMS IN | METHOD OF PROPAGATION. |
|---|---|---|
| 1 Amaryllis | Sept. to Nov. | Offsets |
| 2 Crocus | Feb. and March | Ditto planted in October and November |
| 3 Hyacinths | March to May | Ditto |
| 4 Iris | June | Ditto, planted in Sept. |
| 5 Lily | June to August | Ditto, when the plants are in an inactive state |
| 6 Snowdrop | January and Feb. | Parting the bulbs after blowing |
| 7 Star of Bethelem | March | Ditto, in autumn |
| Pyrennian ditto | May and June | Ditto |
| Umbellated | Ditto | Ditto |
| 8 Tiger-flower | July | Ditto, is a tender plant, should be taken up when its leaves decay, and replanted in the spring, or housed in pots in winter |
| 9 Tulips | May and June | Offsets |
| 10 Narcissus | March to May | Offsets |

The *anemonies* and *ranunculasses* should be planted in *shallow* drills, about six inches apart, and about four inches in the drills, in the months of November or December, and covered with mould about two inches thick. A *few* may be reserved to plant in March, for a later blossoming. Those planted in November and December will require an occasional covering of straw or litter during very severe frosts. The *dahlias* are as tender, in regard to frost, as potatoes. They must be taken up in November, as well dried as possible, and placed in a dry cellar, where they may remain till April.—*See Poynter's Cottage Gardening*, *Repton's*, or *Nicol's Works*, for other information.

ORPIMENT, a yellow sulphuret, is made by a solution of white arsenic in muriatic acid, and adding hydro-sulphuret of ammonia, to produce precipitation.

OSMIUM, is a metal of chemistry, derived from platinum and iridium.

OUNCE, is the 16th of a ℔. avoirdupoise of 7,000 grains, or 437·5 grains. Or, it is the 12th of a troy or apothecaries ℔. of 5,760 grains, or 480 grains. It is also the 16th of a fluid pint in pharmacy, and equal to 480 minims, or 8 fluid drachms.

OXALIC ACID, or salt of sorrel, so called from its being in sorrel, but it is commonly made with nitric acid and sugar, the syrup of which is crystallized, and the oxalic acid is sold in this form, hence the fatal mistakes in vending it for Epsom Salts, though it is highly acid and not bitter. Cream of lime is the best antidote, or chalk eaten quickly.

Oxalic acid is made by pouring 3 strong nitric acid over 1 of sugar, boiling till brown; adding the same quantity of nitric acid, and boiling till without colour. It crystallizes as oxalic acid, equal to 3-5ths of the sugar, but should be redissolved and again crystallized. Chalk or magnesia, in water, corrects its poisonous effects, followed by purgatives.

Oxalic acid may be procured from saracoll with nitric acid; also from mushroom sugar, from cerasin, from inulin, from gluten, from emetina, from guaiacum, from picrotoxa, woody fibre, &c. &c.

Gum with nitric acid becomes oxalic acid.

Chalk and water is the best antidote for oxalic acid.

OXYDATION OF METALS is effected either by the air and heat, by burning with nitrate of potash, by water, by acidulous solution, the excess of acid being subsequently withdrawn by an alkali, or other substance of greater affinity.

Oxidation renders metals susceptible of the action of acids, and hence their variety of salts. If the metal becomes a salt it was previously an oxide, or was oxidized in the process.

To oxidize metals, after they are melted they are exposed in the furnace in a flat dish, and stirred. Zinc and mercury vapourize and require one to be exposed to air previously, and the other a long-necked vessel, that it may not wholly escape, and yet rise to contact with air.

After metals are melted and burned

they form oxydes, 8 of which are white; iron, lead, copper, manganese, and mercury, which are red, or black, or yellow. Silver too is olive, and antimony yellow. Further heat converts these powders into glass, and they are generally soluble in acids or alkalies. Heated with charcoal, carburet of iron, oil, &c. they may be restored to the metallic form.

Iron combines with 28·75 and 48·12 of oxygen in 100, to form its black and red oxide.

Zinc with 24·24
Arsenic with 34·93 and 52·4
Manganese with 28·75 and 57·5
Bismuth with 11·28
Antimony 18·6
Copper 12·5 for red and 2·5 for black
Silver 7·272
Mercury 4 for black and 8 for red
Lead 11·53 for red, and 15·384 for brown.

The alkaline metals absorb still more: magnesium 66·6, sodium 33·3, calcium 38·39, potassium 20, and barium 11·42, all white.

Gold affords 2 chemical oxides, of second character, and its leaves are changed to purple colour by electricity.

OXYGEN-GAS, (*See* ACID,) is usually made by putting powder of black oxyde of manganese into an iron bottle at a red heat in any fire, and conveying the resulting gas, through a tube into water, through which it ascends into a jar, placed over the orifice of the tube. The jar is dipped in the water and raised full, so that the gas gradually displaces it. In a perfect apparatus the iron bottle is often exchanged for a glass one heated by a lamp, and the manganese reduced to a paste with sulphuric acid. The trough, &c. may be purchased of most opticians, and the black oxyde of druggists. The jars should be removed in plates filled with water, and the lutings be made perfect.

*Or*, put chlorate of potash into a tube retort, heat by a large spirit lamp, and receive the gas in phials over water.

*Or*, *precipitate per se* and *minium*, or red lead, when exposed to a red heat, give out the oxygen, which they had previously absorbed from the air at a lower temperature. This operation may be performed in a retort, or glass tube, sealed at one end, a little extended by blowing into it, and bent at an angle; the heat should be gradually applied. For the production of the gas, the small open end of the retort should be placed under the edge of a vessel filled with water in the *pneumatic apparatus*, heat being applied to the closed end.

It may be procured from salt-petre, strongly heated in a gun-barrel, with the touch-hole plugged up, and from which a small pipe of tin, or other substance, fitted to it, is laid under the jar.

Oxygen gas may also be collected in small quantities from growing vegetables, exposed to the solar light, or from the green matter which forms in stagnant pools, by immersing them in a bell glass filled with water.

In collecting any gases, the first portions should be always set aside as impure, as they are mingled with the common air which the apparatus nenessarily contains.

Oxygen gas is colourless, without smell or taste, and may be breathed with impunity for a considerable time; but in its pure state is ultimately found injurious to animal life. It is not dissolved by water, except in very minute quantities. It is rather heavier than atmospheric air; 100 cubic inches of the latter weighing 30·5 grains, and of the former about 3 grains more, or 33·8.

Oxygen combines with all the simple solids.

Oxygen being the primary agent of organic formation, curiosity is directed to the determination of its form and mode of existence and operation. For the present, it may be considered as the largest of the series of atoms, which, with uniform velocities, constitute the gases of chemistry and nature. In circular motions they produce the prismatic and other series, from oxygen and its compounds in red and orange to nitrogen in green (yellow and blue) to hydrogen in its violet and purple, descending to negation or black. This series pervading nature, and producing aerial elasticity, its disturbance and restoration creates the phenomena of electricity, combustion, and many phenomena of action and re-action, of which organizations are simple and compounded results.

Sir H. Davy ascribed this atomic momenta to rotations of the atoms on their arcs.

OXYMEL, is made by boiling 2 lbs. of honey, in a pint of distilled vinegar, to consistency.

*Oxymel of Squills*, by boiling for three hours, gently, 3 lbs. of honey in a quart of squill vinegar.

The compound oxymel of *Carrageheen* is the most efficacious remedy ever discovered for asthma, coughs, and all affections of the trachea and lungs. It is prepared from the well-known Irish moss, or lichen, by Day and Co. Knightsbridge, and has been prescribed by our first physicians.

**PADDLE-WHEELS**, are the rotating levers with which steam or other power acts against water, in propelling a vessel. The idea is not new, for rotating paddles were turned by oxen, &c. in the middle ages. Many patent improvements and varieties of form have been proposed: the chief object is to keep them vertical to the water, and this has been effected by an extra arm, worked by cramps, in connection with the pivot of the float-boards, which turn on the arms.

It has been proposed to work paddles by sails, in certain cases, especially when any accident befals the boiler or works of the engine.

Woodcraft proposes to make paddles of spiral vanes, with increasing angles of inclination with the axis and increasing distance, and has taken out a patent for the idea.

The Galatea, of 42 guns, was lately propelled out of Portsmouth harbour by the use of paddle-wheels, worked with winches by the ship's company. The ship's company, of 190 men, were separated into three divisions; and a trial was first made with two divisions, who performed eleven turns of the paddle-wheels in a minute, and propelled the ship at the rate of two and a half knots. The winches were then manned with the three divisions, when the speed of the paddle-wheels was increased to nearly thirteen revolutions in a minute, equal to three knots an hour. The men were at no time allowed to work up to their strength: and, with a full crew, the Galatea could have gone nearly four knots. The next experiment made, was to try the propelling power of the Galatea's paddle-wheels, contrasted with the power of boats in towing ships. The Briton was towed by her own boats and those of the Pallas, and stood to the westward. When she was about half a mile a-head the Galatea started, and very soon got alongside the Briton in tow. She paddled up on the Briton's larboard quarter, ran across her stern, hauled upon her starboard side, passed ahead of her, fired a broadside, and then returned to her anchorage. The Briton was towed at the rate of two knots two fathoms; the Galatea propelled at the rate of three knots.

**PAINTING HOUSEWORK**, is effected for the most part by priming, and then applying two or three coats of white lead or ceruse, in linseed-oil. Colours are added, at pleasure, of lamp-black, red lead or ochres, or pigments.

Priming, used by painters for new wood-work, is a thin solution of white and red lead in linseed-oil.

*Painters' Oils*,—For *White*. Into a tun of whale, seal, or cod-oil, mix 32 gallons of vinegar, in which have been dissolved some time 12 lbs. of litharge, and also of sulphate of zinc, (white vitriol). In 24 hours draw off all the clear part; and add 2 gallons of oil of turpentine, and 12 gallons of linseed-oil. Again draw off all clear. With the residue mix half the quantity of lime-water; stir well, and draw off the *Prepared Residue Oil*, to be used with common colours.

*Pale Green*.—In one gallon of lime-water mix 18 lbs. of whiting, and also of road-dust, blue-black 5 lbs., 4 lbs. of yellow ochre, and 3½ lbs. of wet blue, ground in prepared residue oil. To each 2 lbs. mix half a pint of linseed-oil, and also of prepared residue oil.

*Substitute for Oil Paints*.—Pour one gallon of boiling-water upon 1 lb. of quicklime and 2 oz. of sugar of lead. When the lime has become completely slaked, the mixture is to be stirred, and it is then fit for use. If required thicker, less water must be used. Colouring ingredients may be added at will. It is said that the cost of this composition paint is about one-thirteenth that of oil-paint, and that it is nearly equal to it in beauty. When exposed to the weather it requires one coat of oil to protect it.

*Flexible Paint*. (For Canvas.) In a hot soap ley, of water 6 lbs., and soap 1 lb., stir well 112 lbs. of oil paint, and use while warm.

*Relief*.—London painters produce striking relief in inscriptions. The main surface is gold, as a middle tint. The strong light of yellow ochre and white is placed at the side, and the upper and under part is in warm shade. A very strong shadow is seen under this, upon the rose-wood, which makes the warm shade appear as a reflected light, and a fainter shadow is put in beyond this. The effect is so masterly, that it is difficult to tell whether the letters are raised or not.—*Whittock*.

*White Paint*.—Skim milk 2 qts.; fresh slaked lime 8 oz.; linseed-oil 6 oz.; white Burgundy pitch 2 oz.; Spanish white 3 lbs. The lime must be slaked in water, exposed to the air, mixed in about one-fourth of the milk; the oil in which the pitch is previously dissolved must be added gradually, then the rest of the milk, and afterwards the Spanish white. This quantity is sufficient for 27 square yards, two coats, and the expense not more than 10*d*.

*Spanish White* is made by grinding fine chalk with 1-10th of alum in water, shaking and drying in the air and then in fire.

*Cheap Paint*.—Gas-tar mixed with yellow ochre makes an excellent green paint, well adapted for preserving coarse wood-work and iron rails.

PAINTING PICTURES.—The first lesson may be taken easily, and cheaply. Take a piece of oil-cloth or a mill-board, a yard square. Paint it twice in drab or lead colour, and rub it with pumice, and wash it. Then practice with the maul stick, a palette, and three or four brushes in white and black. The white may be whiting in milk, and the black lamp-black in beer. A sponge and water will remove one subject, and make way for others, till freedom of drawing is attained.

Priming, in painting on canvas, is sizing and whiting, on which sketches are made with chalk.

PAINTING ON GLASS, is effected chiefly by colours derived from metals. The colours are laid on by fluxes, as soft glass, and easily-vitrified bodies. The colours are fixed by annealing the metals to the glass. The glass used is crown-glass. The annealing is performed in a kiln built for the purpose. The fluxes are minium, calcined borax, salt, and powdered flint-glass. Gold produces the splendid ruby colour. Silver, yellows. Copper, a red. Tin, a white. Iron, a carnation. Ultra-marine, blue. Cobalt, blue. Smalt, light blue. Antimony, yellow and red. Manganese, black. Umber, for browns. The flux in this art is like the oil and varnish of our painting.

The best flux is composed of 16 flint-glass, 6 pearl-ash, 1 salt, and 1 borax. A soft flux is 8 flint-glass, 2 minium, 1 borax. They are vitrified together, and then powdered. Pearl-ash and borax soften, and flint-glass hardens.

An orange stain is produced by silver and antimony for yellow, and pure Venetian, red. The two first are melted together, and when reduced to impalpable powder, are mixed with the red in water. This pigment is then laid on the glass in due form, with a brush, and left to dry. Then burnt-in, and it penetrates through the glass in a fine golden colour. So with other metals, and other colours, some requiring fluxes. It is ably treated at length by WHITTOCK, and being an art not generally practicable, enough has been said of it in this general work.

The fluxes are used in calcining black from scales of iron, jet, and manganese; carnation from red chalk and jet; scarlet from gold and tin, &c, &c.

PALLADIUM is white, with 11 to 12 sp. gr. It dissolves aqua-regia. It is found in combination with platinum.

PALM-OIL. The palm-oil of commerce is obtained from the *Cocos butyracea*, and is a concrete, white, unctuous, substance, rendered fluid and fragrant by gentle heat. As a substitute for tallow, it is the greatest domestic improvement of late years, and it is so abundant, both in Africa and Brazil, that it will, ere long, by cultivation, supercede tallow for candles and soap, and even coals, for gas-making.

The palm-tree, growing on the coast of Africa, furnishes, at the base or origin of its leaves, clusters of a yellow succulent fruit. Each of these bears some resemblance to a grape-shot. The bunches are of different sizes, and the fruit composing them of different shapes, as might be expected from their reciprocal pressure, although naturally round, when not exposed to it. The pulp of this fruit is soft, and of a bright yellow colour—it is from this that the oil is obtained. Within it lies enclosed a hard and thick-shelled stone, of a dark colour, within which is contained a firm white kernel of a pleasant oily flavour. This kernel also affords an oil, which is not yellow, but white—and not fluid, but concrete even in Africa.

The yellow palm-oil is quite fluid while in Africa, and that it is not until it has been exposed to the cold of our temperate regions that it becomes solid—whereas the oil of the kernel is always concrete, or nearly so. Both the white and the yellow oil are obtained by expression. The latter is procured in immense quantities in Africa, where it is partly consumed by the negroes along with their rice and pepper, or fried with their fish; and partly exported to Europe, where its principal use is in the manufacture of soap and candles.

PAPER-MAKING.—The rags of our own country do not furnish a fifth part of what we consume in the manufacture of paper. France, Spain, Portugal, Holland, and Belgium prohibit, under severe penalties, the exportation of rags. Italy and Germany, therefore, furnish the principal supplies of linen rags, both to Great Britain and the United States. They are imported from Bremen, Hamburgh, Rostock, Ancona, Leghorn, Messina, Palermo, and Trieste, and arrive in closely-packed bags, containing each about 4 cwt., according to the respective qualities. The linen rags of England are generally very clean, and require little washing, and no bleaching, before they are ground into pulp. Italian rags, on the contrary, are originally so dirty, that they require to be washed in lime; while the greater part of the rags from the north of Europe are dark in colour, and coarse in texture.

No substance but rags enters into the composition of first-class paper. Many experiments have been made upon substances proposed as substitutes for rags in the manufacture of paper. The bark of the willow, the beech, the aspen, the hawthorn, and the lime, have been made into tolerable paper; the tendrils of the vine, and the stalks of the nettle, the mallow, and the thistle, have been used for a similar purpose; the bine of hops would, it is affirmed, produce paper enough for the use of England; and patents have even been granted for making paper of straw. The process of bleaching coarse rags will, however, render the use of inferior substances unnecessary for many years.

Paper-mills in the south of England are set in motion by water-power, as in a flour-mill. But, in the north of England, where coals are abundant, paper-mills employ steam-engines; and, in manufacturing paper, heat is essential.

In a long room, filled with dust, (though dust might be removed by Strutt's Belper apparatus,) women assort the rags. Each woman stands at a frame, or table, whose top is covered with wire: on her left is a quantity of rags; on her right a box divided into three compartments. On a part of the table an upright knife is fixed. Each spreads a few on the wire frame, before which she stands; and, as she shakes them the dirt passes through the wire to a box beneath. If the pieces are three or four inches square, she throws them into one of the compartments of the box on her right, according to its quality. If a piece requires to be cut, she draws it across the knife. Seams are put by themselves; since sewing-thread would produce filaments in the paper. An active workwoman can sort and cut a bag of a hundred weight a day.

The rags are then put into large square chests, and steam admitted, by which they are boiled with lime for some hours.

From the steaming shed they are removed into an upper room, and subject to the movements of a large horizontal wheel, which is connected with several oval cisterns, or troughs, about ten feet long, and four or five feet broad. These troughs are called *Engines*, which wash, tear, and beat the rags.

The washing is performed in a trough 10 feet long, 4½ feet broad, and 2¼ feet deep, and is made of wood, lined with lead. In this works an iron roller, 22 inches in diameter, and 26 inches wide. There is also an apparatus for conveying pure water into the trough, and for carrying off the foul water. The roller being set in motion, about a cwt. of rags are put into the trough, and as much water is let in as will raise the whole within an inch or two of the brim. The roller's surface presents a number of bars or knives, projecting more than an inch; and beneath the roller is a plate composed of bars or knives, of the same kind. The roller makes about 160 rounds in a minute, and the rags are carried with great rapidity through the knives: and, as the roller is depressed upon the plate, or elevated, the rags are drawn out, bruised, or cut. Above the roller is a cover, in which are two frames of wire cloth, communicating with the water-pipes. The cleansed mass is then removed to a press, for the purpose of driving out the water.

The process of bleaching then reduces every description of linen rag to an uniform whiteness. The rags, for this purpose, are placed in a receiver or chamber made of wood, from which external air is excluded, and into this chamber are conveyed pipes, communicating with a retort, in which chlorine or oxymuriatic gas is formed, by heating a due proportion of manganese, common salt, and sulphuric acid. In a few hours the rags are white, and subsequent operations of washing and bruising purify them from smell.

They are then let off into the beating-engine, of the same construction as the washing-engine, except that the knives of the roller and the plate are closer together, and the roller is moved with more rapidity. Being ground for some hours, the rags assume the appearance of fine pulp, somewhat resembling milk. In this engine *size* is introduced, but, in writing papers, the size is applied after the sheets are made.

The pulp is now conveyed by a valve to the chest, a large circular vessel, which will contain several engines full of pulp, or stuff. In the paper-machine it is twelve feet in diameter, by five in depth. An agitator is made to revolve round it, by which the stuff is suspended.

In general, the sheet is made by hand in a mould, but in others by machinery. A frame, or fine sieve, is dipped into a vat, and this vat is supplied with stuff from the chest, while the stuff is kept warm by a copper within the vat, to which heat is communicated by a steam pipe, and kept agitated by machinery within. The workman, called a vatman, is provided with two moulds of fine wire. A moveable raised edging determines the size of the sheet, and the vatman, putting the edging on one of the moulds, dips it vertically into the stuff; and bringing it to the surface horizontally, covered with pulp, he shakes it gently, and then pushes the mould with the sheet towards his fellow-workman, called the coucher; and taking off the deckel, applies it to the second mould. The coucher turns the mould over upon a felt, or flannel, upon which the sheet remains; and placing a felt on the sheet, he is ready to turn over another from the second mould. The heap is then subjected to the action of a powerful press. The sheets, after this pressure, have acquired sufficient consistency to enable them to be pressed.

The sheets being parted are dried, five or six together; next sized, by dipping; again dried and pressed; examined, to throw out any damaged sheets, or to remove knots; and, finally, put into quires and reams for sale.

But, in making by machinery, at one extremity of a long range of wheels and cylinders, there is a stream of pulp as thin as milk and water, flowing over a moving plane, and at the other extremity the stream has become perfectly solid, and is at once wound upon a reel as hard and smooth paper.

At one extremity is the chest, full of stuff or pulp. At the bottom of the chest, and above the vat, there is a cock, through which a continuous stream of pulp flows into the vat; which is always, therefore, filled to a requisite height. From the upper to the lower part of this vat, from the left to the right division, a portion of the pulp flows upon a narrow wire frame, which constantly moves up and down, called a sifter. Having passed through the sifter, the pulp flows still onward to a ledge, over which it falls like a sheet of water over a smooth dam. Here it is caught upon a plane, which presents an uninterrupted surface of five or six feet, upon which the pulp seems evenly spread, as a napkin upon a table. This plane is constantly moving onwards with a gradual pace, and it has a vibrating motion from side to side. It is also perforated all over with little holes; and, in fact, is an endless web of the finest wire. The pulp at the end of the plane, upon which it first descends, is fluid; at the other end it is still soft, like wet blotting-paper. The pulp does not flow over the sides of the plane, because a strap, on each side, constantly moving, and passing upon its edges, regulates the width. When it has ceased to be fluid it is yet tender and wet; and a wire cylinder, which presses upon its surface, leaves a succession of lines upon it. When off the plane of wire, another roller, clothed with *felt*, upon which a stream of cold water is constantly flowing, subjects it to pressure. A tight surface of flannel, or felt, then moves onwards like as the web of wire, and, like the wire, is endless; or, united at the extremities, like a jack-towel. The inclined plane of the stretched flannel gradually absorbs its moisture, and two rollers powerfully squeeze it. Afterwards, it travels up another inclined plane of flannel, and passes through a second pair of pressing rollers. The paper now is quite formed, but fragile and damp. From the last pair of cloth-pressing rollers the paper is, therefore, received upon a small roller, and guided by it over the polished surface of a large heated cylinder. The soft tissue now begins to smoke; but the heat is gradually apportioned. From the first cylinder, or hot drum, it passes to a second, larger, and much hotter, and all the roughness gradually vanishes. It finally passes over a third cylinder, hotter than the second, and having been subjected to the pressure of a blanket, which confines it on one side, while the cylinder smooths it on the other, it is caught upon a last roller, and passed to a reel, as perfect paper.

A supplementary machine, however, receives it off the reel; and as it mounts upon the drum, a circular knife cuts it into two breadths; and a series of sharp teeth strike against it within, and divide it, by a stroke of invariable regularity, into the requisite lengths. The process takes two hours, and from the commencement, when the pulp flows out of the vat upon the web of wire, till the paper into which it is formed is received upon the reel, is less than two minutes. The web of wire travels at a rate which produces twenty-five superficial feet of paper per minute.

In the machine, the thickness of the paper is regulated by the quantity of stuff which is allowed to flow out of the chest; and all that is required to render this thickness invariable, is an invariable speed in the motion of the machine. If the web of wire travel at a rate that will make twenty-five feet of paper a minute, and the chest discharges five gallons of stuff in the same period, there can be no change in the thickness of the sheet. But if the machine move with greater speed, as thirty feet in a minute, while the chest discharges the same, the paper will be thinner.

The great modern improvement has been the drying of the sheets without removal. Each cylinder is heated by steam, from a pipe communicating with its hollow part within, and the heat is gradually increased. If the first cylinder which receives the sheet be taken at the temperature of 80°, the second is 100°, and the third 120°.

The cutting-machine, which may or may not be applied to the paper-making machine, is an extremely ingenious contrivance, invented by Cowper.

Mr. Dickinson, who makes the best paper in the market, employs a hollow cylinder, the surface of which is pervious, and is covered with woven wire; and this revolves in a vat of pulp, though not completely immersed; but by the axis, which is a hollow tube, there is a communication to a pair of air-pumps, and by their action the paper is formed, and made to adhere to the cylinder, and is afterwards detached from it to an endless cloth, which conducts it to the pressing-rollers. The pulp for this machine is much more dilated than for any other mode of making paper, and therefore admits of the fibres which compose it being longer.

After the sheets of paper, completely formed and cut by the process described, are taken from the machine-room, they are subjected to a very careful examination. This work is performed by young women; and it is their business to remove every knot or speck in each sheet, and to lay aside those which have any rent or hole. The sheets, thus finished, are next subjected, in their full size, to the action of a powerful press. They are then cut round the edges by a plough. The sheets are finally counted into quires of 24 sheets, folded in quires, put into reams of 20 quires; pressed in reams; and, lastly, tied up. These improvements have had the effect of reducing the price of paper from 25 to 30 per cent.; and hence a volume, like the present, which, 15 years ago, would have been cheap at a guinea, is afforded at its present low price.

*India Paper.*—The material employed by the Chinese is the liber, or interior bark of a sort of mulberry, commonly called the paper-tree, and known to botanists under the name of *broussonetia papyrifera*. Kempfer has described the process pursued in China in the manufacture of this paper.

*Rice Paper.*—The substance called, in England, " rice paper," is made of the branch of the plant, in China.

Mr. Gill remarks, that the Chinese " rice paper" is an organized vegetable production, much resembling, in its structure, the pith of elder. He thinks cylindrical pieces of elder or other pith might be found in this country, quite large enough to bear slicing in this manner; and which slices, after being flattened by pressure between plates (possibly warmed or heated) might serve as substitutes; and be as capable of receiving any colours.

*Paper from the husks of Indian corn.* To 128 gallons of water put 10 quarts of good lime, or about 6 lbs. of good alkali, and place therein about 110 lbs. of clean corn-husks or flag-leaves. Let the water be moderately heated over a moderate fire, for two hours, when they will be ready for the engine, there to be worked, and managed, in every respect, as rags are for making paper.

*Straw Paper.*—Take any quantity of straw, hay, or other vegetable substances, and boil it in a solution or ley of pot or pearl-ash, or other alkali or lime, in the following proportions, viz. to 115 lbs. of straw, hay, or other vegetable substance, add from 15 to 20 lbs. of the salts or ley of pot or pearl ash, or other alkali or lime, and boil them about 30 minutes, or steep the materials in the solution a few days, or until saturated, then draw off the water, and put them into a common engine, to be manufactured into paper, like rags.

*Paper from Wood.*—Any wood may be reduced to shavings, which are thrown into a caldron of water, and set to boil. To every 100 lbs. of shavings, from 12 to 18 lbs. of any vegetable or mineral alkali (according to its strength) are to be added. 100 lbs. of wood will make from five to seven reams of paper.

*Paper Linen*, or *Papier linge*, consists of paper, made to resemble damask and other linen so closely, that it is impossible, without examination, to detect the difference: and, even to the touch, the articles made from the *papier linge* are very much like linen. The price is very low: a napkin costs only a halfpenny; and, when they are dirty, they are taken back at half price. A good-sized table-cloth sells for only 10*d.* and for the same price is sold a rouleau of paper, with one or two colours, for papering rooms, or for bed-curtains.

*Oiled Paper.*—Dr. Farady, in his admirable volume on manipulations, states that hydrogen gas may be made with zinc and dilute sulphuric acid in oiled paper, and conducted, through paper tubes, to a bason, as a trough, and received in oiled paper tubes. Also, that the steam of a tea-kettle may be conveyed in oiled paper tubes, so as to heat a steam-bath itself of oiled paper.

*Paper Tubes*, to convey hot air, carbonic acid, or coal gas, may be made by rolling a sheet of paper and tying it with thread. Gum, or paste, at the edges makes it air-tight, especially if varnished and corked.

*Waxed Paper.*—Lay it on a clean hot plate, and rub it with wax tied in muslin.

*Paper-Hangings* are in pieces of 12 yards long, by 20 inches wide, and printed by wooden blocks, with great rapidity. It is to be regretted that the splendid scenes and varied colours of French paper-hangings are not imitated in England.

*Sea-grass Paper.*—1. All rocks, roots, and shells, to be carefully separated from it.—2. The dust to be cleared from it, by beating it.—3. To be steeped in lime-water, in order to discharge the salt from it, and thus prevent decomposition.—4. To be partially pulverized, and then bleached perfectly white by oxy-muriate of lime.—5. To be made into pulp in the usual manner, by beating, or in a paper-engine.

PAPER PLOUGHING-MACHINE.—This consists of a stout square board, the size of the paper, when cut, furnished, on the upper surface, with four deep grooves, one on each of the four sides, for guiding the plough. The plough itself is of a peculiar construction, in two parts; one part squaring upon the edge, and in the groove, of the board; while the second portion carries the knife, and moves upon the first in a vertical direction. The paper to be cut being placed upon the cutting-bench, under the grooved board, the latter is brought down upon the paper by an iron-screwed rod, working between the board and a beam overhead. The paper being firmly secured, and the upper board forming the gauge by which it is to be cut, the workman places the plough in one of the grooves, and moving it to and fro in an horizontal direction, effects the cutting of one edge of the paper; the plough is then transferred to another groove, and a second edge cut; a similar operation with the third edge completes the object. As the paper is cut away, the knife descends, until the whole is taken off, and the parellelism of the knife is accurately maintained throughout; in this way the three sides of the paper are expeditiously cut, with one adjustment only; nor is the difficulty of putting in the paper so great as in the binders' common cutting-press.—*Mech. Mag.*

PAPIER MACHE, is a substance made of cuttings of white or brown paper, boiled in water, and beaten in a mortar, till they are reduced into a kind of paste, and then boiled with a solution of gum arabic, or of size, to give tenacity to the paste, which is afterwards formed into different toys, by pressing it into oiled moulds. When dry, it is covered with a mixture of size and lamp-black, and varnished.

PAPIER VEGETALE.–The best kind of tracing paper, permitting either the use of ink or black-lead pencil; besides being of a purer colour than any other, is obtained in France from the root of the *althæ officinalis*.

PARALLEL MOTION, is a very important principle in mechanics; that by which the motion of a piston is rendered a rotatory action, and a rotatory motion a rectilinear one; so that, if we get power, we may, by this means, apply it in the way desired. The crank of the old spinning-wheel is the most common method, but it causes the piston-rod to *wabble*. To prevent this *wabbling* has been the subject of much contrivance. White's American is most ingenious. He connects the piston with the inner of two wheels, which works inside an outer one of double its size, and goes twice round the outer, in an epicycloid equal to the diameter of the outer, which is upon an axis connected with the works. Another plan is, to connect the piston-rod by a bar, with a rotating crank, which revolves the axle.

PAREGORIC ELIXIR.—In 16 oz. of alcohol, (in which has been mixed 4 oz. of caustic ammonia) digest 3 drs. of flowers of benjamin, and of crocus (peroxide of iron,) 2 drs. of opium, and ¼ dr. of oil of aniseed. The dose, from ½ dr. to 1 dr. is anodyne and diuretic. *Or*, In 2 pints of alcohol mix 1 dr. each of opium and flowers of benjamin, ½ dr. of oil of aniseed, and 2 scrs. of camphor.

PARSLEY ROOT, is diuretic. The leaves are supposed to produce epilepsy and inflammation of the eyes. The seeds are carminative.—*Fool's Parsley* is poisonous, and liable to be mistaken for parsley, but it is inodorous.

PARSNEP ROOT, is nutritive, but its smell is disagreeable. Sugar and wine are made from it. The seeds are aromatic. In the *Cow Parsnep* the root and leaves are emollient, and the seeds a specific in hysteric spasms. The juice of the head renders the hair curly, and young shoots are substituted for asparagus. It exudes sugar.

PASTE, is commonly made of flour and hot water, to which size and gum are often added. Alum, added to paste, prevents its turning sour, and it preserves glue.

PATENTS, are privileges for a limited term, to enjoy the commercial profits of any useful invention. No evil can arise from an increase in the number of patents taken out; because, if the discovery be worthless, the public is not injured; and, if it be valuable, the greater the number of valuable discoveries which are made known the more is the public benefited. In general, patentees are not over-rewarded. The delay and expense of experiments, and the disinclination of society to depart from established practices, occasion a large proportion of them either to gain little, or even sustain loss. Patents ought to be cheap; because the granting of a patent is merely recognising, in an inventor, his property in his own invention for a limited period, on condition that he shall afterwards give the invention to the public; for, without his consent, no other person can avail himself of it.

Many who gave evidence before the committee of the House of Commons, in 1828, were of opinion, that no patent ought to be granted for the discovery of a principle, unless the discoverer specified some mode of rendering the new principle useful to the public: and, in that case, it may be presumed, they were of opinion that every application, of which the new principle should be found capable, ought to be secured to him, however inefficient his mode of applying it might be.

New principles may be discovered, by persons who do not see any useful application of them; yet, as soon as they are made known, such application is quickly made by others. If the discovery of the magnetic principle had not been communicated, the mariner's compass might never have been invented. If the first person who discovered that steam is capable of exerting great expansive force had obtained a patent for that discovery, and thereby given publicity to the fact, it is probable that amongst the numbers who would have attempted to render such force available for useful purposes, some one would have been successful; and that the steam-engine, and many other inventions with which the force of steam is connected, would have been employed beneficially some centuries earlier.

In the opinion of Mr. Roberts, all specifications of patent inventions should be officially published, at as early a period after they are lodged in the patent-office as their nature will admit of, in some work to be established for that purpose, which should be published, say once or twice a month. The work might be designated "The Official Record of Patent Inventions."

A patent of monopoly ought to be granted for a period for the following subjects:—

The discovery of a principle.

A new application of a known principle.

A new combination of machinery.

A new application of machinery.

A new construction, process, or method.

Importations of any of the above.

Communications, by natives or foreigners, of any of the above subjects.

No patent should be valid if the whole of the thing patented shall have been described in any printed book, and any patent for a discovery or invention, the knowledge of which can be proved to have been surreptitiously obtained within the United Kingdom, to be void; and no communication of a discovery or invention, which may have been made under an injunction of secresy, to be considered a sufficient publication to vitiate a patent.

The law of patents, like all the laws of England, have become so complicated and absurd, tending only to promote the interests of the legal profession, that a new and simple law has been loudly called for, and is before the Legislature while this volume is printing.

At the same time, no law will be just which does not make provision for persons palpably thrown out of employment by the invention. If of value to the public, the indemnity should proceed from public funds, and a portion of the profits for three or four years should be applied to this fund. Many important inventions are kept back by conscientious persons, rather than ruin all their neighbours. Two or three years provision would be sufficient.

PAVEMENT.-Fleet-street and Cheapside, London, have recently been repaved, and the method employed was, to remove all the old stones, and a considerable portion of the soil beneath them. A firm bed was then made with broken granite, in pieces similar to those used in Macadamizing, levelled with coarse gravel. Upon this, new stones, cut about fourteen inches long, by four wide, and nine inches deep, were carefully laid, the gravel filling-in being omitted. When a considerable portion had been so far finished, a quantity of thin mortar cement was plentifully distributed over the stones, and urged into the crevices between them by repeated sweeping. The paving was then well rammed, and fine gravel strewed over it completed the process. A beautiful street-road has been obtained.

Iron paving was tried in squares of imitation stones, but heavy pressures on one cover raised the other, and the necessary level was destroyed.

The secondary thoroughfares of London have been advantageously Macadamized.

PEA.—The native country of the pea is unknown, but it has been cultivated from remote antiquity, and forms one of the most valuable of culinary plants. The varieties which have been produced by cultivation are very numerous, and differ in the colour of their flowers, their number, and that of the seeds, the time of ripening, and in stature, some being low plants of a few inches, and others attaining the height of 10 or 12 feet. Peas are nutricious, and especially when green. When ripe they are used for soup, and are prepared by freeing them from the husks, and splitting them in mills constructed for the purpose. They are sometimes ground into flour, which is mixed with that from wheat by bakers, but the bread is rendered heavy and flatulent.

*Early Peas* may be sown in pots of about nine inches in diameter, and placed in a hot-bed about the middle of January. Two dozen peas are placed in each pot in a circular row, and a circle of twigs a foot high is stuck in beside them. About the middle of March the peas will be 14 inches high, and may then be transferred to the open border.—*Tr. Hor. Soc.*

In Norfolk, peas are considered to be so exhausting a crop that tenants are in some places restricted by their covenants from growing them at all. But, there are many gardens in which south borders in peas have been grown for a hundred years.

Peas may be sown in a warmly-sheltered spot, if the weather is mild and tolerably dry. The best way to sow them is in drills, about three feet apart, that they may be sticked. The best sorts to sow are the charlton and hotspurs, for early peas, as they are great bearers; for late bearers, no pea equals the blue Prussian pea.

PEACHES and Nectarines require very similar management to apricots; except that, in the winter-pruning, the shoots require more general topping.

In peaches, nectarines, and apricots, the winter pruning should be done just as the buds are beginning to swell, which is generally in February. The blossom buds are then easily distinguished from the leaf shoot buds. Apricots bear principally on the wood of last year's growth; but likewise on small spurs that arise from older wood. In winter pruning, the trees should be trained to spread like the sticks of a fan. Four or five inches from shoot to shoot is close enough. All decayed, and likewise overgrown wood must be cut out. The large and luxuriant wood seldom bears. The small and middle-sized wood is always to be preferred. Some of the shoots will require to be shortened, but not many of them. About the middle of May the young shoots will be growing from almost every part of the tree, and will require thinning; this must be done by pulling off with the finger and thumb. The fruit should be thinned when about the size of sparrows' eggs.

PEAR, the fruit of the *pyrus domestica*, a tree growing wild in many parts of Europe, and cultivated in all temperate climates. In the cultivated plant, the fruit varies exceedingly in size, colour, taste, and time of ripening. At the present day, more than 200, fit for the table, are enumerated, and constant accessions are made every year; for the seeds never reproduce the same variety without more or less modification. There are numerous varieties of pears, cultivated solely for the purpose of making *perry*, a liquor analogous to cider, and prepared nearly in the same manner. The wood is fine-grained, of a yellowish colour, and susceptible of a brilliant polish: it is not subject to the attacks of insects, and receives a black dye remarkably well, when it so much resembles ebony that it can only be detected by the specific gravity.

PEARLS, are produced by a testaceous fish of the oyster kind, which lives in the waters of the East and West Indies, and in other seas in warm latitudes. They are found, in some parts of the globe, in clusters of a great number, on rocks in the depths of the sea. Such places are called *pearl-banks.* The finest and most costly pearls are the Oriental. Some consider pearls to be unfructified eggs; others, a morbid concretion, or calculus, produced by the endeavour of the animal in the shell to fill up holes in the shell: others consider pearls as mere concretions of the juice of which the shell has been formed, and with which the animal annually augments it.

PEARL ASH.—The common name for carbonate of potash.

PEARL BARLEY, is common barley deprived of its husk and rounded, and polished in a mill.

PEARL POWDER, is a watery precipitate of the nitric solution of bismuth, with the addition of muriatic acid. Sulphuretted hydrogen, or coal gas, turns it black.—*Or*, with fine powder of French chalk mix an equal weight of magistery of bismuth.

PECTIC ACID, is the acid of jellies. Take any quantity of carrots; wash and clean them well; then, by means of a rasp, reduce them to a pulp; express this strongly, and wash the marc with distilled or filtered rain-water until it cease, by expression, to be coloured. Mix fifty parts of the washed marc, expressed, with 300 parts of distilled water, and 1 part of a solution of caustic potash; then heat the mixture till it boil, and let it boil for a quarter of an hour, or until a portion of the fluid coagulate completely into a jelly with an acid. Pass, now, the boiling liquor through a cloth, and wash the mass with distilled or filtered rain-water, mixing these washings, passed through the cloth, with that which was strained while hot. The mixed fluid should become thick and gelatinous on cooling. This contains a pectate of potash, which may be decomposed by a small quantity of muriate of lime, largely diluted with distilled water, by which means an insoluble gelatinized pectate of lime is formed, which should be well washed on a cloth. The washed pectate is next to be boiled, for a few minutes, with distilled water, acidulated with muriatic acid, to dissolve the lime and the starch; and, by throwing the whole on a cloth, and washing it with distilled water, the pectic acid is procured.

PECTORAL BALSAM OF LIQUORICE, is chiefly composed of paregoric elixir and oil of aniseed.—*Paris.*

PECUL, is a Chinese weight of 135⅓ lbs., much quoted in the Indian Seas. Five are nearly 6 cwt.

PELLITORY OF SPAIN, is imported in root from Turkey and Barbary, and is used as a masticatory in the toothache, and in powder in intermittents, or as a sternutatory for tooth powder.

PENDULUMS, are used as measures of time, because their vibrations are governed by the motions of the earth, which motions govern all falling bodies in known times. The times of vibration are as the square roots of their lengths. Kater determined the second's pendulum in London, lat. 51° 31′ 8·4″, to be 39·13829 inches; or, at the level of the sea, 39·1386. As the square root of 39·1383 is to 60, so is the square root of any other length to its vibrations. Then $\sqrt{39 \cdot 1383}$ (6·261) and 60 being constant, or as 1 to 9·58, so 9·58 is a constant multiplier of the square root of any other time for the vibrations; and 9·58 is a constant divisor, when, having the vibrations, we want the length.

PENS, a very important article, till lately made of quills; but these are now generally superceded by the more permanent and less troublesome steel pens. These are used in the public offices with great saving, and children are taught to write with them, especially where economy of time and money is an object.

Mordan and Co. have a patent for an oblique steel-pen, which obviates the defects to which former metallic pens were liable; and embodies a very novel, and, at the same time, an exceedingly valuable principle in its oblique form.

Most persons fail to attain the art of writing with a pen in the true position; *i. e.* with the hand removed a little to the right, and the tip of the pen pointing to the right shoulder, when the slit of the pen will be in the direction of the writing, and both nibs of the pen addressed fairly to the paper. This pen supplies a perfect remedy for this defect, for the oblique direction of the slit being that in which the writing usually slopes or leans, at an angle of about 35°, both nips are brought equally down upon the paper, the writer is not confined to any particular position, but may use the pen freely and without restraint of attitude.

PEPPER, *(piper;)* an extensive genus of plants, whose fruit consists of a berry containing a single seed. The species are strictly confined within the tropics, and abound particularly in the equatorial regions of America. The *P. nigrum*, which furnishes black pepper, is a native of the East Indies, and is cultivated on an extensive scale. It is a climbing plant, and is supported on a pole, or small tree, planted for this purpose, which gives to the pepper-grounds an appearance similar to hop-fields. The pepper of Malacca, Java, and especially of Sumatra, is the most esteemed. Its culture has been introduced into the Isle of France, and thence into Cayenne and West Indies.

White pepper is nothing more than the best and soundest of the berries, gathered when fully ripe, and deprived of their external skin, by steeping them in salt-water for about a week, at the end of which time the skins burst; they are then dried in the sun, rubbed between the hands, and winnowed to separate the hulls; it is much less pungent than the entire berries. The leaves of the *P. betel*, a native of the same parts of the globe, serve to enclose a few slices of the areca-nut, called betel-nut, and a little shell lime, which substances together form a masticatory as much in use among these nations as is tobacco in Europe and America.

PEPPERMINT CORDIAL.–Into 1 oz. of refined sugar drop 75 drops of oil of peppermint, and, while grinding with the sugar, add to the quantity of 1 pint of alcohol, which liquid mix with 10 pints of alcohol, and 10 gallons of water. Add ½ oz. of alum, to fine.

Peppermint Drops.—Similarly mix and treat 2 lbs. of sugar and 4 oz. of peppermint-water; and, if needful, add a few drops of oil of peppermint.

Peppermint Lozenges.—In mucilage of gum dragon, flavoured with oil of peppermint about 2 drs. mix 2 lbs. of sugar and 2 oz. of starch.

PERCH, the main timber of a carriage, which extends through the hind and fore spring transom, or bars, by which the principal part of the upper carriage is supported. The hind part is supported and united to it by hooping two extending timbers, called wings, on the side. The fore part is fixed to the perch by a strong piece, hooped at the top, and framed through the fore transom. Some carriages have a horizontal wheel in the front, the same as the crane-neck carriages, and these have no hooping-piece to the perch, but are secured by side-plates. Those on the general principle have, at the bottom in front, a flat piece called a tongue, which goes through a large mortice in the fore axle-tree bed, and through which the perch-bolt passes.

Sometimes the perch is bent, called a compass perch, for the purpose of admitting the body to hang low, or to form a more agreeable line to the shape. When the carriage is intended for a whole or horizontal wheel, the perch has no hooping-piece, but is bolted by the plates at each end to the inside of the transoms. Plating the sides with iron is a great improvement, and always must be done to perches required to be light in appearance.

To the straight or compass perch iron plating on the sides is a great addition, as it will admit the timbers to be so much reduced, that sufficient strength is preserved though but half the usual size; the plates, as fixed edge-ways to the sides of the perch, will support ten times more weight than if flat on the bottom.

PERCUSSION LOCKS, have no pan. In the place of the pan, a small tube projects horizontally from the side of the gun, and in this tube another small tube stands perpendicularly. The cock, instead of being formed to hold a flint, is shaped somewhat like a hammer, with a hollow to fit upon the last tube. On this tube a little cap of copper is placed, in the bottom of which is a chemical mixture that kindles by percussion. This percussion is produced by the cock, which therefore requires a very strong spring.

The powder is made of different materials; among others, of mercury, purified nitric acid, and spirit of wine freed from water. The copper-caps in which this powder is placed are two and a half lines long and two lines wide. Sometimes the powder is also formed in pills, and then a somewhat different contrivance is required to place the pills, covered with a little wax, to protect them from moisture, in the small tube.

PERFORATING GLASS, Earthenware, &c.—Mr. Marsh says, the only tools requisite are a few worn-out three-edged hand-saw files. These being generally made of cast-steel retain, when ground, a very fine point, which is of the utmost importance. In order, however, to give them the requisite degree of hardness, it is necessary to make their ends, for about an inch, red-hot, and then plunge them into cold water. By this treatment they become hard and brittle; care is, therefore, required in grinding them to a proper point, which is easily effected on a common grindstone. He generally gives them a few rubs on a fine oil-stone after the grinding, so as to produce a very fine point. A cylindrical piece of any sort of wood, about two inches long, terminated by a half-round end, having a hole about the tenth of an inch in diameter, through its axis, may either be fastened into a common bench vice, or on a table. This constitutes the only support required. Suppose that a glass to cover the face of a wheel barometer is wanted, through which it is sometimes necessary to make a perforation for the purpose of passing the screw of the nonius through; a proper piece of glass being selected, is to be marked with a dot of ink on the place where the intended perforation is to be made; the glass is then to be held horizontally by the left hand, on and immediately over the hole in the wood support above mentioned. A three-edged file having been hardened, and ground to a fine point in the manner above described, is held firmly between the fore-finger and thumb of the right hand, precisely in the position that a pen or pencil is retained when writing. The pointed steel is then to be repeatedly impinged against the glass over the spot intended to be perforated, taking care not to use too much violence. In a short time the outer surface is removed, and, by a continuation of the process, a conical piece is forced from the under surface of the glass through a hole in the wood support; the perforation so produced never exceeds in size a pin's head, but may be made as large as required by holding it over the hole in the support, and working round its edge with a fine pointed file. In this way, after a little practice, and in a very few minutes, may be perforated, with ease, all descriptions of glass, from the thinnest crown to the thickest plate, without any danger.

Wine-glasses or tumblers may, also, be easily perforated in a similar manner; but he mostly employed another process for them. These being made of a softer sort of glass, require only to be moved by the hand backwards and forwards, in the manner of drilling, on the sharp point of the file, with the occasional assistance of a little oil and emery. Indeed, any sort of glass may be perforated in this manner, but not so quickly as by the method of punching. All the varieties of china and earthenware may be perforated by either of the above processes with certainty.

PERFUMERY.—The essential oils or essences obtained in the south of France are those of roses, neroli, petit-grain, lavender, wild-thyme, thyme, and rosemary. These essences are distilled in the usual manner. They obtain, by putting into the body of the still 40 lbs. of rose-leaves, and 30 pints of water, and proceeding to distillation, 15 pints of rose-water. They then continue the operation until they have thus obtained 200 pints of water, termed No. 1. In this first distillation, they obtain an almost imperceptible quantity of the *essence of roses*; but in the second it becomes more apparent; and, finally, in the fifth it becomes notable.

In the distillation of *orange-flowers*, they also obtain the *essence of neroli*, now become of remarkable importance. If they would obtain this essence they follow the ordinary process, and repass the waters of the first distillations upon new flowers. On the contrary, when it is intended to prepare orange-flower water of a good quality, they draw off a fifth part only of the water placed in the cucurbit.

*The essence de petit-grain* is obtained by distilling the leaves of the orange-tree; the quantity of essence they afford depends upon their freshness. With respect to those of lavender, wild-thyme, thyme, and rosemary, they present no peculiarities in their extraction.

*Spirituous Essences.—Rose, orange, jasmine, tube-rose, cassia, violet, and other flowers.*—They take three water-baths, furnished with covers, and put into one of them 25 lbs. of one of the perfumed oils above-mentioned, and 4 gallons of spirit, marking 3-6ths; they stir the whole every three-quarters of an hour during three days; at the end of that time they decant the spirit thus perfumed, and pour it anew into the second water-bath; they again repeat the same operation in the third bath, and the spirit then obtained is perfected. By continuing the process with the same oil, they likewise obtain inferior qualities, indicated No. 2, 3, and 4.

PERPENDICULARS, are lines directed to the earth's centre, and two, a mile asunder, do not deviate one minute from parallelism.

PERSPECTIVE, is the art of fixing distant points on a plain surface, in such manner as they relatively appear to a fixed eye. This plain surface is compared to a pane of glass interposed between the eye and the distant objects; and the eye being fixed, or the view taken through a fixed hole in front of the pane of glass, a true perspective drawing places every object in the same relative position as they are in when so viewed from such fixed point through a pane of glass. Perspective is an analysis of the laws by which objects are so seen on a pane of glass, or the perspective plane, and, with some consideration, a man might invent his own perspective. Varley's is the shortest and simplest practical introduction.

It will be observed, that the point of the glass directly opposite the eye is that which governs all other points, right and left, above and below, and that lines from it and to it, like strings, controul the position of the whole. This is called *the point of sight.*

Then there are general relations to the right and left, and above and below; and these are governed by a horizontal line, running through the point of sight, for right and left objects, and a perpendicular for those above and below the ground plane.

Of course, the point of sight, as to the picture, is as high as the eye, and if six feet above the ground level, all objects less than six feet high will be directed upward to it, and all above six feet will be directed downward to it.

If an object, or line lengthwise, is directly in front, it will be parallel to the horizontal line of the drawing; but if perpendicular to the perspective plane, it will be directed to the point of sight. Hence, it is a general rule that all objects *on* the ground plane vanish in the point of sight. But if neither parallel nor perpendicular to the perspective plane, then they vanish obliquely to the point of sight, or to the right and left in the horizontal line.

Perspective effect is best understood by looking down a vista of trees, or down a very long gallery, for then the diminution of size as distance, and the vanishing point in the distant point, opposite the eye, is apparent.

The same rules that guide in these simple cases apply to every part. The lines drawn for the front vista determine the heighth of the same objects, as the trees, or the sides of the room, at certain distances; and if similar objects are to be placed in any part of the picture, they must, at equal distances from the perspective plane, be made of the same size as in the vista or long gallery.

The heighth of the horizontal line is determined by that of any near object, at the point of it opposite the eye, and this line being pencilled across the drawing, the basis is laid. It is not necessary that the point of sight should be in the centre of the drawing, since you may fill the paper with all the objects, either to the right or left, but they must all be referred to the true point of sight.

The first line to draw is that of the nearest object, and it should be proportioned to the heighth of the horizontal line. If this is 6 feet, and that it is 36 or 24, it should be six times or four times greater. This, then, is the scale for the whole, and lines drawn from its top and bottom, or any parts, to the horizontal line, determine the same sizes all over the picture.

The situation of oblique lines is determined by diagonals of direct lines. Thus, the gable end of a house is directly over the centre of the diagonal of its two sides, found in the vanishing-line, and so with others.

To divide a part of a vanishing-line, draw a line from its upper point, parallel to the horizontal line. Then, from *any* place in the horizontal line, draw a line through the lower point of the line to be divided. Then the divisions of the first parallel line so cut off, carried to the place in the horizontal line, will intersect the vanishing line in its true proportions. For the first parallel is the same as a parallel plane at the distance, and the divisions would then be equal, but the method determines a diagonal corresponding with the obliquity of the vanishing line.

All lines having, in nature, the same inclination to the ground plane must have a direction to the same point in a perpendicular line parallel to the perspective plane; so that the direction of the first being drawn, the others are directed to the very same point, whether the point be above or below the horizontal line.

In perspective, all lines beneath the horizontal line, or heighth of the eye, run up to the point of sight; and all lines above the horizontal line run down to the point of sight.

The guiding rule, used for drawing in perspective, consists of two slips, turning on a screw in a mortice at the end of a stick; and these held between the eye and the upper lines of a building, so as to coincide, show the exact vanishing directions of the building, so as to lay it on the paper truly. The top of the stick is the upper near corner, and the slips are the vanishing lines.

Claude placed his point of sight and horizontal line a third from the groundline, by which he brought in trees and skies. Poussin made his point of sight and horizontal two-thirds above the ground-line, and hence had more ground than sky. For, this line being the heighth of the painter's eye, no surface which is level can be seen, but collapses into a point. The perspective level is infinite, therefore the natural horizon, within a few miles, is a little above it; but, in viewing the sea on the shore, they meet at five miles, while, on a mountain of 3000 feet, the perspective and natural horizon do not collapse into one line till objects are 60 miles distant.

When actual measure of distances and heighths is not practicable, the angles at the eye may be taken, and the tangents of these angles set off on the paper from the common scales; but *mark*, these tangents must be enlarged as the radius of the scale is to the distance of the eye from the drawing. If the eye is 12 inches and the radius of the scale 3 inches, then, if the tangent of the angle gives 2 inches, it must be set off four times more, or at 8 inches, or the paper from the point of sight. And, in altitudes not in the vertical plane, the distance of the eye must be multiplied by the secant of the horizontal angle, so that if 12 inches, and the secant 2, the proportion must be 24 to the radius 3, or 8 times 2, or 16 inches be set off. A few points, thus determined, enable the draughtsman to finish the whole.

The mechanical means are the tracing-pane, with the eye fixed in a hole. The pane in squares, with a hole for the eye. A plain mirror, drawn upon, or the points fixed by it, with or without squares. The camera obscura, with a roughened glass. The camera lucida, or reflected image. Wren's, Carey's, Peacock's, or Ramsden's parallel rods.

In perspective drawing, we seek to delineate the objects as they appear on the prospective plane, which plane is the base of a cone, of which the eye is the apex.

PERSPIRATION, from the skin, disperses in the air the atomic motion of the animal system, constantly accumulating by respiration, and in performing this effect, in health, carries off 28 oz. of the fluids in every 24 hours. Its odour varies in different animals, and parts of the same animal, and it consists of carbon and nitrogen, this last being constantly accumulated at the skin, and, therefore, impregnated with the carbon of the substance. Any obstruction leads to undue atomic excitement in the system, and to various degrees of fever. An increase is promoted by ipecacuhana, mezereon, guaiacum, and antimony. Camphor, dulcamara, citrate of ammonia and potash, sulphur, and pure water, also, are diaphoretics.

Perspiration, from the bodies of beasts and men, maintains an equilibrium of heat, and certain fluid matters are separated from the blood by the thick network of capillary vessels and cells constituting the skin. This effluvium is usually so fine, that we cannot see it with the naked eye; but it becomes visible, if we hold the hand on cold glass or polished metal; also, if the perspiration is strong, in a cold temperature. The surface of a full-grown man contains 15 or 16 square feet, and Sanctorius weighed and kept an account not only of all the food that he consumed, but also of every thing that passed from him, and thereby proved that a great part not only of the fluid, but also of the solid substances that a man consumes, leaves his body by perspiration.

The substance of the body is, in many diseases, particularly in fevers, converted into aeriform fluids, by an evaporation so increased and accelerated; that the strongest man is entirely worn away in a few days, without having lost any thing except through his skin. The other advantage of perspiration is the preservation of a suitable degree of warmth in the body, and the reduction of an immoderate heat. The temperature of man is about 92° to 99° Fahrenheit, and the greater the heat which the body is exposed to, the greater is the perspiration, and the more actively is the atomic motion conducted off.

PETROLEUM, is much thicker than naphtha, resembling, in consistence, common tar. It has a strong, disagreeable odour, and a blackish or reddish-brown colour. During combustion, it emits a thick black smoke, and leaves a little residue in the form of a black coal. It is more abundant than the first, mentioned variety, from which it does not appear to differ, except in being more inspissated. It occurs, oozing out of rocks, in the vicinity of beds of coal, or floating upon the surface of springs. In the Birman empire, near Rainanghong, is a hill containing coal, into which 520 pits have been sunk for the collection of petroleum; and the annual product of this mine is 400,000 hogsheads. It is used, by the inhabitants of that country, as a lamp-oil, and, when mingled with earth or ashes, as fuel. It is found abundantly in Kentucky, Ohio, and New York, where it is known under the name of Seneca or Genesee oil. It is used as a substitute for tar, and as an external application for rheumatism and chilblains.

In a late ingenious patent it is used as a means of decomposing water, by bringing it, simultaneously with water, in contact with hot coke or iron; and the hydrogen and oxygen of the water cause a powerful heat for many purposes.

PEWTER, is a compound of tin 3 and lead 1, or, in other proportions for the three kinds of pewter, plate, trifle, and ley. The first is used for plates and dishes; the second, trifle, for pewter-pots; and the third, ley, for wine and spirit measures. Their sp. gr. 7·248, 7·359, and 7·963.

PHOSPHATE OF SODA, or *sal mirabile perlatum*, or *tasteless purging salt*, is made by dissolving 14 parts of crystallized carbonate of soda in 21 of water, at 150°; to this is to be added, gradually, 5 of phosphoric acid, sp. gr. 1·85, boiling the mixture for a few minutes, filtering it, and letting it crystallize by cooling; from 14 to 15 of phosphate of soda crystallizes.

PHOSPHORESCENCE, is the property which certain bodies possess, of becoming luminous without undergoing combustion, as, when we rub or heat them, or in consequence of the action of the living principle, or of decomposition. Two pieces of quartz emit light on being rubbed together. Light is seen in breaking lumps of sugar. A variety of blende (sulphuret of zinc), on being scratched with a knife, emits a fine yellow light.

PHOSPHORIC ACID, is generated in all animals, and displayed especially in the urine. By Barry's experiments, it appeared in all pharmaceutical extracts, and Paris says, it exists in all articles of food, and, as phosphate of lime, exists in bones, and in all vegetables. It appears in all the substances of animals, and their products. In the mineral kingdom, it is found in lead and iron, in silex, in calcareous earths, and in union with lime, sometimes in whole mountains, as in Spain and Hungary. The acid is formed by the combustion of phosphorus, and so to speak is an oxide. But it is also made by distilling phosphorus with nitric acid, or with sulphuric acid or chlorine. It is soluble in water, which takes up 1·687 with increase of temperature. Distilled with charcoal or inflammables, they abstract its oxygen, and it returns to the state of phosphorus.

Phosphoric acid and barytes form a salt, which, with great heat, forms grey enamel.

Phosphoric acid and lime, or phosphate of lime, is insoluble in water till calcined. It absorbs grease, and serves to polish stones and metallic surfaces.

Phosphates of potash and soda are made, and the latter is used, as a purgative salt, having no flavour; also in assays, and in soldering.

Phosphate of ammonia abounds in urine, and much employed as a flux, and in colouring glass.

Other phosphates are formed, but not applied to any purpose.

PHOSPHORUS, one of the most singular of natural substances, is always found in combination as an acid or a salt, commonly in animal bones and urine, and in the mineral kingdom as phosphate of lime. It is made by separating the oxygen from the acid by distillation into water with a fifth of powdered charcoal, and it falls in drops. These strained through leather in warm water, have a sp. gr. of 1·77. But the tendency to imbibe oxygen is so great, that it must be kept under cold water. It melts at 90°, and inflames at 148°, with intense light reforming the acid. In oxygen, it inflames with great violence, and in chlorine it burns with a faint light. It combines also with iodine, hydrogen, and sulphur, with the last forming fire bottles, when two sulphur, and three phosphorus. It dissolves in oils, and renders them luminous.

*Phosphorus.*—Wohler recommends, as likely to afford phosphorus at a very cheap rate, to distil by a strong heat ivory black, with half its weight of fine sand and charcoal powder. A silicate of lime is formed, and the carbonic oxide and phosphorus come over.

If phosphorus be put with alcohol into a bottle, and shaken for some time, it may be obtained in powder of the utmost tenuity, which, when diffused through the alcohol, appears as if it consisted of a multitude of minute crystals.

At the temperature of 60° F., or upwards, carbon in the form of animal charcoal, or lamp-black, causes the inflammation of a stick of phosphorus powdered with it, and the effect takes place either in the open air, or in a close receiver of a moderate size.

*Phosphorus Bottle.*—In a phial, mix,

by gentle heat for half an hour, 2 drs. of phosphorus, with 1 dr. of lime. *Or*, in a phial, with water, melt 1 dr. of phosphorus, and 15 grs. of white wax. On cooling, as the mass grows solid, turn the phial till the inside is coated, when discharge the water, and dry cool.

*Canton's Phosphorus* is formed by mixing three parts of calcined oyster-shells in powder, with one of flowers of sulphur, and ramming the mixture into a crucible, and igniting it for half an hour. The bright parts will, on exposure to the sun-beam, or to the common daylight, or to an electrical explosion, acquire the property of shining in the dark, so as to illuminate the dial of a watch. It will, after a while, cease to shine; but, if we keep the powder in a well-corked phial, a new exposure to the sun's light will restore the phosphorescent quality.

Temperature has a marked effect on the emission of light by these bodies. When they are shining, the luminous appearance ceases if they are exposed to the cold of a freezing mixture. It becomes more vivid by applying heat; and if it has ceased, it may be renewed by applying a stronger heat, so that a piece of any solar phosphorus, which has apparently lost its power, may by heat be again made to shine. Some of the phosphorescent bodies just mentioned, after their luminousness is over, upon partially heated iron, yield on fusion a very vivid light. Lime is the substance possessing this property in the most remarkable degree. If a piece of calcareous spar is placed on charcoal before the compound blow-pipe, it emits a light so vivid and white that it can scarcely be looked upon.

*Phosphorus Match Light.*—Into a large flask, heated in a sand-bath, put eight parts of pure phosphorus, which half melt, without allowing it to oxidize. Add four equal parts of magnesia; begin to mix the whole at a heat of 234·5°; reduce the heat gradually to 106·25°, and in about an hour you will have a fatty powder, which is to be put into bottles, and, when cold, carefully stopped. This substance will instantly inflame a common match.

PHYSICIANS, COLLEGE OF, London. This learned body has, for the last century, obtained and even commanded the respect and homage of public opinion. A succession of learned and enlightened presidents have influenced its policy, and dispersed its distinctions among the ablest professors of medicine that ever distinguished any nation. The effect has been to excite useful competition in the Medical Colleges of the Sister Kingdoms, and no fault now attends the medical profession but the undue multiplication of its numbers. In sound learning, and in personal talent, it has long vied with the other professions; and it is scarcely any disparagement to them to state, that, for some years, it has generally transcended both; for, in theology and law, men rise by favour and patronage; but, distinction in medicine can arise only from personal merit and character.

PHYSICS, are developements of the laws of matter in power; therefore, strictly mechanical and geometrical, for geometrical physics, unless strictly *mechanical*, are a solecism in terms. Mathematical *principles* of natural philosophy, of cookery, and of theology, are three equivalent solecisms. Mathematical demonstration applies *only* to abstract number and quantity, and no demonstration applies to any virtues or qualities, which theory or fancy may conjoin with the pure abstractions of number and quantity.

But, as motion and quantity are in other words velocity and quantity, so all phenomena of mere motion or mechanical power is susceptible of demonstration: yet, with these, no gratuitous force can be mingled, which is not the palpable product of matter and motion.

As we know only matter and its motion, as power, so we are not justified in referring phenomena to charms, sympathies, antipathies, powers of suction, or any species of talisman, faith in which bewildered reason down to the 17th century, *though it was constantly asserted that they merely were names of obvious effects.* But, in the 17th century, a new nomenclature was introduced. To charms and suction succeeded attraction; to antipathy and reversion, repulsion; and to talismans, caloric, &c. &c. all scions of the former stocks, and scholastic disguises of the older superstitions under new names; while more presuming, because treated as ultimate powers, and even as causes of power; and classed in genera and species with insolent and ridiculous pedantry.

The species called *universal gravitation*, or weightiness, cannot be inferred from the fall or weight of a body on the earth, seeing that such fall and weight are mere necessary effects of the simultaneous orbit, and rotatory motions of the earth; fall being directly at orbit velocity, and inversely as rotatory. That is, the 98,060 feet, the orbit motion of the earth per second, by 6024, the rotation is 16·087, the fall per second.

The fundamental fact, relative to the fall of the moon, adduced in proof of the *law of gravitation*, is to the truth in the ratio of 16 to 128,000, or only as 1 to 8000: or the moon falls from the tangent of its orbit 128,000 feet in a minute, not 16 feet.

Every case of *attraction* must arise from modification of forces, without the affected bodies, seeing that each body has force only in the direction in which it moves; and, therefore, if moving eastward, has no force to make another body move westward towards it; or, in other words, bodies cannot impel each other from their distant sides.

Every case of *repulsion* must arise from modification of forces, without the affected bodies, seeing that bodies have force only in the direction in which they move; and, therefore, a body moving eastward cannot, at the same time, push another westward, or from it.

A system of heterogeneous bodies, moved in a right line, form a train; because the rare bodies have less momentum than the dense ones. Or, such a system rotated, with their centre in the same place, are dispersed, because the impulse of each particle is a tangential right line. But if a progressive motion and a rotatory are *simultaneous*, and if the progressive is greater than the maximum of the rotatory; and if the rotatory is such that the increase of velocity, by rotatory deflection, renders the direct momenta of the various densities equal; then neither the train nor the tangent dispersion will take place, but a compact balanced sphere will be the result, such as the planets.

The investigation of the *external forces*, which causes attractions and repulsions of various kinds, is the knowledge of the real operations of nature, and includes the fundamental principle of all physical science. To be ignorant of these forces, and their mode of action, is to be in intellectual darkness, and superstitious vassalage.

Matter in motion is power or force universally, and there is no other sensible or known power. Power is, as the product of the matter by the velocity. Chemical power is the motions of atoms. Mechanical power is the motions of masses. Action is the parting with power, reaction receiving it.

In the energies and changes of nature, production is always a result of action and reaction; that is, two things universally produce one thing, and not one thing by itself another thing. There must be an agent, and a patient.

PICKLING.—To give pickles a fine colour. Heat the liquor, and keep it in a proper degree of warmth, before it is poured upon the pickle. Pickles should never be handled with the fingers, but taken out by a spoon, with holes in it, kept for the purpose. The strongest vinegar must be used for pickling. It must not be boiled, as thereby the strength of the vinegar and spices will be evaporated. By parboiling the pickles in brine, they will be ready in half the time they would otherwise be. When taken out of the hot brine, let them get cold, and quite dry, before you put them into the pickle. The articles to be pickled should be perforated with a larding pin, in several places, by which means they will the more readily imbibe the pickle.

*To Pickle Walnuts.*—Make a brine of salt and water, with a ¼-lb. of salt to a quart of water. Soak the walnuts in this for a week, and if you wish to have them ready the sooner, run a larding pin through them, in half a dozen places, which will make them much softer and better flavoured. Put them into a stew-pan with the brine, and give them a gentle simmer. Lay them on a sieve to drain, then put them on a fish-plate in the open air, a couple of days, or till they turn black. Put them into unglazed or stone jars, about three-parts full, and fill up the jars with the following pickle; and when they have been done about a week, open them, and fill them up again, and so on continually, or else they will be spoiled.

To every quart of the strongest vinegar add one ounce each of black pepper, ginger, shallots, and salt; half an ounce of allspice, and half a drachm of Cayenne. Put these into a stone jar, covered with a bladder, wetted with the pickle; tie over that some leather, and set the jar on a trivet, by the side of a fire, for three days, shaking it three times a day, and then pour it, while hot, on the walnuts, and cover them down with caoutchouc covers.

*To make Saur Kraut.*—Take a large strong wooden vessel, or cask, resembling a salt-beef cask, and capable of containing as much as is sufficient for the winter's consumption of a family. Gradually break down or chop the cabbages (deprived of outside green leaves) into very small pieces; begin with one or two cabbages at the bottom of the cask, and add others at intervals, pressing them, by means of a wooden spade, against the side of the cask, until it is full. Then place a heavy weight upon the top of it, and allow it to stand near to a warm place, for four or five days. By this time it will have undergone fermentation, and be ready for use. Whilst the cabbages are passing through the process of fermentation, a very disagreeable fetid acid smell is exhaled from them; now remove the cask to a cool situation, and keep it always covered up. Strew aniseeds among the layers of the cabbage during its preparation, which communicates a peculiar flavour to the saur kraut, at an after-period. In boiling it for the table, two hours is the period for it to be on the fire.

*To make Peccalilla.*—This consists of all kinds of pickles, mixed and put into one large jar—girkins, sliced cucumbers, button onions, cauliflowers, &c. broken in pieces. Salt them, and put them in a large hair-sieve in the sun to dry for three days, then scald them in vinegar for a few minutes; when cold put them together. Cut a large white cabbage in quarters, with the outside leaves taken off and cut fine, salt it, and put it in the sun to dry for three or four days; then scald it in vinegar, the same as cauliflower, carrots, three parts boiled in vinegar and a little bay-salt; French beans, rock-samphire, radish-pods, and nastertiums, all go through the same process as girkins, capsicums, &c. To one gallon of vinegar put 4 oz. of ginger bruised, 2 oz. of whole white pepper, 2 oz. of allspice, ½ oz. of chillies bruised, 4 oz. of turmeric, 1 lb. of the best mustard, ½ lb. of shalots, 1 oz. of garlic, and ½ lb. of bay-salt. The vinegar, spice, and other ingredients, except the mustard, must boil half an hour; then strain it into a pan, put the mustard into a large basin, with a little vinegar; mix it quite fine, and free from lumps; then add more; when well mixed, put it to the vinegar, just strained off, and, when quite cold, put the pickles into a large pan, and the liquor over them; stir them repeatedly, so as to mix them all; finally, put them into a jar, and tie them over, first, with a bladder, and afterwards with leather. The capsicums want no preparation.

*To Pickle Samphire.*—Put what quantity is wanted into a clean pan, throw over it two or three handsful of salt, and cover it with spring-water for 24 hours; next put it into a clean saucepan, throw in a handful of salt, and cover it with good vinegar. Close the pan tight, set it over a slow fire, and let it stand till the samphire is green and crisp; then take it off instantly, for should it remain till it is soft, it will be totally spoiled. Put it into the pickling pot, and cover it close; when it is quite cold, tie it down with a bladder and leather, and set it by for use. Samphire may be preserved all the year, by keeping it in a very strong brine of salt and water, and, just before using it, put it for a few minutes into some of the best vinegar.

*To Pickle Mushrooms.*—Put the smallest that can be got into spring-water, and rub them with a piece of new flannel, dipped in salt. Throw them into cold water as they are cleaned, which will make them keep their colour; next put them into a saucepan with a handful of salt upon them. Cover them close and set them over the fire four or five minutes, or till the heat draws the liquor from them; next lay them betwixt two dry cloths till they are cold; put them into glass bottles, and fill them up with distilled vinegar, with a blade of mace, and a tea-spoonful of sweet oil in every bottle; cork them up close, and set them in a dry cool place; as a substitute for distilled vinegar, use white-wine vinegar, or ale. Allegon will do, but it must be boiled with a little mace, salt, and a few slices of ginger, and it must be quite cold before it is poured upon the mushrooms.

*Pickle for Meat*, consists of brown sugar, bay-salt, common salt, each 2 lbs., saltpetre ½ lb., and water 2 gallons, or in proportion.

*To Pickle Vegetables.*—A thoroughly-saturated brine is made of salt, which requires about 4 lbs. to a gallon. Into this brine the substances to be preserved are to be put, and kept covered. French beans, artichokes, olives, and samphire may be thus preserved.

PICROMEL, or RESIN, is the essential constitute of bile, and forms nearly a ninth of it in bulk. When dry it resembles hardened bile, and is soluble in water and alcohol. It also combines with acids. It displays no ammonia, but consists of carbon 54·5, hydrogen 1·8, and oxygen 43·7, but the analysis must be incorrect, since bile contains soda and lime, and resin much hydrogen.

PICTURE-CLEANING, is effected by removing the old varnish, and revarnishing. Soluable varnishes are removed with very hot water, applied with a sponge, or cloths, and any hard parts rubbed off with bread-crumb, or the end of the finger. Gum varnishes are taken off by warm oil; but, if hard, 2 oz. of pearl-ash, in a quart of water made warm, may be applied. Spots may be removed with soap-suds applied to them only; and if not efficient, spirits of wine, or essence of lemons, may be touched on those parts, and cleaned off, the second with olive-oil, and the water for the former.

In cases of coated dirt, cover with spirits of wine, and renew for ten minutes, and then dilute and wash off with water, without rubbing. Repeat, till the old varnish is removed.

Old oil-varnishes cannot be removed without injuring the picture. Essence of lemons, cleaned off with olive-oil, is the only means, but always dangerous. The first surface may also be removed with pumice-stone.

Re-varnishing should be effected by mastic varnish, for which, *see* VARNISHING.

PIGEON.—In their wild state, the pigeon-tribe live on high trees, generally in flocks. They feed on seed, though sometimes on fruit, retaining their food in the crop for some time. The greater proportion of the species build on elevated situations, forming a loose nest of small twigs, and wide enough to contain both sexes; the female lays 2 eggs, several times a year. They pair for life, though they assemble in flocks.—They are found in every part of the world, but the species are most numerous in warm climates. Of all the varieties of the pigeon, the most remarkable for its attachment to its native place is the messenger or carrier. This is distinguished from the others by a broad circle of naked white skin round the eyes, and by its dark blue or blackish color. They obtained their name from the circumstance of their being used to convey letters from one place to another. The bird is brought, for this purpose, from the place where it is intended to convey the information; a letter is tied under its wing, and it is set at liberty; and it wisely directs its flight, in a straight line, to the very spot from whence it had been taken.

PIG OF LEAD; the eighth part of a fodder, amounting to about 250 pounds weight.

PIGMENTS, or substances mixed with oil, or fluid for painting, are, for

*White*, white lead, flake white, prepared clays as Spanish white, or whiting troyes, &c.; and it is best used with nut-oil.

*Black*, lamp-black and ivory-black, the first is the soot of oil, the second calcined bone, peack stones, charcoal, &c. &c.

*Red*, either vermillion from quicksilver and sulphur; red lead or calcined lead; Venetian or Spanish red ochre: calcined Oxford yellow ochre; lake from alum and Brazil wood or scarlet rags; or whiting coloured with Brazil wood, called rose-pink and fleeting.

*Blue* is ultramine, or calcined lapis lazuli: Prussian blue from sulphur and alum; indigo when pure; verditer rendered opaque with white lead.

*Yellow* is the purified shotover ochre; King's yellow, arsenic and sulphur; Dutch pinks, tinged whiting; terra sienna ochre.

*Green*, verdigris from copper and acids; verdigris and Dutch pink, King's yellow and blue; white-lead gives them body, but fleeting.

*Orange* is a combination of reds and yellows.

*Purple* is the combination of reds and blues.

*Brown* is ochre, either unburnt or burnt umber. Reds, blacks, and yellows combined make various browns, as vandyke, &c. &c.

These are mixed with linseed, nut, or walnut, sun-flower, colza, spike or poppy oils. Water and spirits of wine require body in gum, size, milk, wort, &c. And oils for raped *drying* are prepared by boiling or combinations.

*Bright green.*—In prepared fish-oil 1 gallon, and lime 6, water 1½ gallons, mix 28 lbs. of yellow ochre, 42 lbs. of road-dust, 28 lbs. of wet blue, and 2½ lbs. of blue black; add 2 galls. of linseed-oil, and 1¾ galls. of prepared residue-oil.

*Lead colour.*—In lime-water 5 galls. mix 112 lbs. of whiting, 5 lbs. of blue black, white lead, ground in oil, 28 lbs., and road-dust 56 lbs.; add 1½ galls. of prepared residue-oil.

*Brown red.*—In 8 galls. of lime-water mix 112 lbs. of Spanish brown, 224 lbs. of road-dust, and use with 12 galls. of equal quantities of fish, linseed, and prepared residue-oils.

*Yellow.*—Substitute yellow ochre for Spanish brown.

*Black.*—Substitute lamp-black, or blue-black.

*Stone colour.*—In 4 galls. of lime-water mix 112 lbs. of whiting, 28 lbs. of white lead ground in oil, 56 lbs. of road-dust, and add 2 galls. of prepared fish-oil, and 3½ galls. of linseed-oil, and of prepared residue-oil.

The above paints are cheap, hard, and durable; owing to the road-dust, (or ground gravel), and are much used for common work exposed to the weather.

PILLS, are valuable, efficacious, and convenient family-medicines, but, as they become hard and evaporate, they ought to be made with any syrup, or gum-water, nearly as they may be wanted, from materials kept closely corked, or packed. In this way they cost about two-pence per dozen.

Pills are made by hand, or cut by grooved machines, in very common use. It is usual to roll the substance, and if each pill is to be a scruple, or 20 grains, and the substance is an ounce in a roll, we know that it is to be cut into 24; if each pill is to be 10 grains, then into 48; and if 5 grains, into 96. If the oz. is rolled out two feet long, then an inch rule determines the length of each pill, since in 2 feet there are 24 inches, 96 quarter inches, and 192 eighths of inches. Every family may mix and divide their own pills.

*Aloetic Pills* are equal parts of socotorine aloes and soap, mixed with simple syrup.

*Compound Aloetic Pills* are 1 oz. of spiked aloes, half an oz. of extract of gentian, and some drops of oil of caraways, with simple syrup.

*Assafœtida Pills* are equal parts of assafœtida, socotorine aloes, and soap, mixed with gum-water.

*Colocynth Pills* are colocynth 1, socotorine aloes 2, scammony 2, sulphate of potash and oil of cloves each one quarter, formed with oil and gum-water; and the best of habitual purgatives.

*Mercurial Pills* are made of half an oz. of purified mercury, ¾ of an oz. of rose-confection, and 2 drs. of liquorice-root, make a perfect mixture. The compound is 12 drs. or 720 grs., which, at 6 grs. to a pill, is 120 pills.

*Strengthening, or Tonic Pills*, are made of 2 oz. of powdered sulphate of iron, 3 oz. of camomile-flowers, and ¼ of an oz. of oil of peppermint, or 2580 grs., which, at 6 grs. each, is 430 pills.

*Plummers' Pill*, for cutaneous affections, is calomel, and precipitated sulphuret of antimony 1 part, guaiacum 2 parts. Dose 5 to 10 grs.

*Pilla Cochia*, for a purge, is 5 aloes, 3 scammony, 4 colocynth, and 1 oil of cloves. It may be bought by the ounce.

*Pill Ointment.*—Beat up together, and boil, till of thick consistence, 1 lb. of flowers of toad-flax and of hogs'-lard.

PINE.—A genus of plants, consisting of lofty evergreen trees, which, with spruces and larches, form the most striking feature in the vegetation of temperate climates. About thirty species are known, of which nearly one half inhabit North America. The red Canadian pine *(pinus resinosa)*, a northern species, inhabiting the whole Canada from the Atlantic to the Pacific, and also found in the northern and eastern parts of the United States. In Canada and Nova Scotia, it is called *yellow* pine. It does not constitute a large proportion of the forest, but occupies small tracts of a few hundred acres, where the soil is dry and sandy, and grows either alone, or in company with the white pine. The trunk rises to the height of seventy or eighty feet, by about two in diameter at base, and is chiefly remarkable for its uniform size for two-thirds of its length. The wood is compact and fine-grained, rendered heavy by resinous matter, and is highly esteemed for its strength and durability. Michaux esteems this tree of so much importance, that he recommends its introduction in the north of Europe.

The wild pine, or Scots fir, forms, almost exclusively, immense forests, north of lat. 55°, but, in more southern parts, is chiefly found on the mountains. The trunk attains the height of eighty feet and upwards, by four or five in diameter, and the timber is applied to a great variety of uses, and especially is excellent for masts. These, with the timber in other forms, are exported from Riga, Memel, Dantzic, and other parts of the north, to the other maritime states of Europe, and particularly to England. In those districts where it abounds, houses, as well as furniture, are generally constructed of it, and it furnishes excellent charcoal for forges; but, a more important product is the resinous matter, consisting of tar, pitch, and turpentine, of which articles it supplies four fifths of the consumption in the European dock-yards. The pine has, besides, the advantage of growing in extremely-different soils, and exposures. The name of *red*, or *yellow deal*, is given in Great Britain to its wood, while the wood of the Norway fir *(pinus picea)* is called *white deal.*

Pine-forests are extremely liable to be frequently ravaged by fire; and from their great combustibility it is extremely difficult to arrest the progress of the flames when once they have gained footing. In some parts of France, the following method is practised with success:—If a fire breaks out in a forest, a second is kindled at a point directly opposite, when a current of air sets from the first to the second, which carries the flames to a common centre, leaving the lateral woods uninjured.

PINE-APPLE, was originally found in Peru. It passed from Brazil to the West Indies, and thence was transported to the East Indies, where it has long been successfully cultivated. The pine-apple is most readily reproduced by planting the terminal tuft of leaves; but, in our green-houses, it is far inferior to the tropical fruit, and yet is very generally cultivated. In one or two of the southern provinces of Spain, it is raised in sheltered situations in the open air. Some of the species have crowns, and the fruit of most of them, though small, is eatable. The *B. pinguin* has the fruit separately in clusters, and not in a cone, and the leaves afford a fibre, which is manufactured into cordage, or sometimes into good cloth. From the pine-apple is made very good wine, which turns in about three weeks, but recovers by longer keeping. The fruit is also sometimes preserved, and, when taken out of the syrup, iced with sugar.

Pine-apples may be kept a considerable time, by twisting off their crowns, which are generally suffered to remain and to live upon the fruit, till they have absorbed all the juices.

PINION, the catches of axles, in which the teeth of a wheel are to work.

PINK SAUCERS.—Wash the petals of safflower, till no colour disengages; dry, infuse 8 oz., and 2 oz. of subcarbonate of soda in 2 galls. of water; strain, add 4 lbs. of French chalk, fine scraped by Dutch rushes, on which precipitate the colour by citric or tartaric acid.

PIPES.—The resistance in pipes is as the velocity directly, and as the circumference inversely.

Pipes are proved by the height of water they sustain, and their effect on a loaded safety-valve.

The contents of a pipe is practically determined by squaring the diameter in inches, and then the pipes contain the same number of lbs. in every yard, and each lb. is a pint nearly.

Wooden pipes consist of trees bored often with iron augers of successive sizes, but, generally, by water, or steam-power, with a fixed auger, and the trees drawn upon the work. Iron-pipes are cast in short lengths, and screwed together, with leather, or caoutchouc between the joints.

200 yards of iron-pipe have expanded 7 inches, by heat, and 180 feet 1·75.

A pipe of lead, the hundredth of the diameter thick, will bear a column of water, 100 feet high. Inflexible pipes are made of lead, iron, tinned copper, wood, or stone, or earthenware; but flexible ones of leather, or caoutchouc, and the latter are found to answer best in breweries and distilleries.

PINS, are made of brass wire. When the wire is received at the manufactory, it is wound off from one wheel to another, and passed through a circle of a smaller diameter in a piece of iron.

Being thus reduced to its proper size, it is straightened by drawing it between iron pins, fixed in a board in a zigzag manner. It is afterwards cut into lengths of about four yards, and then into smaller pieces, every length being sufficient for six pins. Each end of these is ground to a point by boys, one of whom sits with two small grindstones before him, turned by a wheel. Taking up a handful, he applies the wires to the coarsest of the two stones, moving them round, that the points may not become flat. He then gives them a smoother and sharper point on the other stone: a lad of twelve years of age can point 16,000 in an hour. When the wire is pointed, a pin is taken off from each end, till it is cut into six pieces. The next operation is to form the heads, or *head-spinnings*, as they are termed: this is done by a spinning-wheel. One piece of wire is with rapidity wound round another; and the interior one being drawn out, leaves a hollow tube between the circumvolutions. It is then cut by shears, every two turns of the wire forming one head. These are softened by throwing them into iron pans, and placing them in a furnace till they are red-hot. As soon as they are cold they are distributed to children, who sit with anvils and hammers before them. These they work with their feet, by means of a lathe. They take up one of the lengths, and thrust the blunt end into a quantity of the heads, which lie before them; catching one at the extremity they apply it immediately to the anvil and hammer, and, by a motion or two of the foot, the point and the head are fixed together. The pins are thrown into a copper, containing a solution of tin and wine lees. Here they remain for some time, and, when taken out, their brass colour has become changed to a dull white. In order to give them a polish, they are now put into a tub containing a quantity of bran, which is set in motion by turning a shaft that runs through its centre, and thus, by means of friction, the pins become bright. They are now separated from the bran, which is performed by a mode exactly similar to the winnowing of corn; the bran flying off, and leaving the pin behind fit for sale.

PLAGUE; a disease characterized by a contagious typhus, and entire prostration of the strength, and certain local symptoms, as buboes, carbuncles, and livid spots. The latter are the peculiar characteristics of the plague. In the progress of the disease, the face often becomes red, the respiration quick and uneasy, and bilious, green, or bloody and black matter is vomited. The delirium often becomes fierce; the urine is sometimes turbid, black, whitish, or bloody; and hemorrhages take place, when death does not immediately ensue; buboes appear in the groins, the arm-pits, the parotids, and other places, with carbuncles, small, white, yellowish, black spots over the whole body. Death, in many cases, takes place on the first day, and, frequently, in a few hours after the appearance, but sometimes not till the second or third day. It is considered favourable if the buboes and carbuncles appear at the same time, are very numerous, and terminate in suppuration. They either terminate in suppuration, or become indurated, and are healed or cut out.

Doctor Madden, who paid much attention to this subject, says, he is thoroughly persuaded that plague is both contagious and infectious; at one period epidemical, at another endemical; in plain English, that the miasma may be communicated by the touch, or by the breath; that in one period it is confined to a particular district, and at another is disseminated among the people. But if plague have one form more decided than another, it is the endemic. He considers, that the contagion generally derives its violence and virulence from want of ventilation, the plague chambers in the East being generally closed and crowded with patients, by which means the air in them is rendered extremely foul.

Both plague and malaria, says Doctor M., have their origin in putrefaction, exhaling an invisible vapour, which can only be estimated by its consequences. Malaria originates in the decomposition of vegetable matter. Plague, according to my opinion, originates in the putrefaction of animal matter. The production of both, of course, depends on certain states of moisture and heat, which, in other places, of even a damper climate and higher temperature, are wanting to the generation of these diseases.

When the disease is completely developed, it is contagious, and to this is owing the terrible devastations which it causes.

PLANET, a sphere which revolves round the sun as a centre. We know of seven large ones, at distances from 37 to 1600 millions of miles distant, and 4 small ones, called asteroids. There may be many others not yet discovered.

The visible ones to the eye are Venus, Mars, Jupiter, Saturn; but Mercury and Herschel are seldom to be seen, one being so near the Sun, and the other so remote.

There are also secondary bodies, or moons, which revolve round the planets, 1 attached to the Earth, 4 to Jupiter, 7 to Saturn, and 6 to Herschel.

Their motions are examples of that transfer of motion which produces all phenomena, small as well as great. They exist in a space filled with gas, through which the massive motion of one is transferred to another; but the Sun, being 556 times larger than the whole united, and 1,400,000 times larger, for example, than the planet of the Earth, its motions govern, and they do but slightly affect one another.

The Sun is in progressive motion with the whole, just as Jupiter or Saturn are in motion with their moons. The Sun and planets, too, act and react on each other through the gas in space, and hence the Sun is made to move round a small orbit, just such as the hand performs when it revolves a stone fixed to the end of a string. The distances and bulks have exactly adjusted themselves; and the effect of the simultaneous joint motions is an orbit of each at the adjusted distances. The progressive motion tends to force them into the line of the Sun's direction, and the circular motion of the gas of space counteracts that tendency.

The planets move their moons by exactly similar mechanism, their progressive motions, and their orbits of reaction. But, as an absolute force, thus acting from a centre on different bodies, would generate a circular orbit only when a planet is a point, and the planets have bulks which perform an exterior and inner orbit, so these would compensate in result, by carrying the centre through an egg-form orbit; the outer half generates the aphelion distances, and the inner half the perihelion.

Then the solar forces being diffused in the areas of the plane of the Sun's motion, and areas of circles being to each other as the squares of the radii, or, in this case, the distances; the *forces* in the orbits are *inversely* as the squares of the distances, or as $\frac{1}{D^2}$. But the periods are inversely as the forces, therefore directly as $D^2$, and they are also as the length of the orbit, which is as D. Then, multiplying P as $D^2$ into P as D, we get $P^2$ as $D^3$. This is Newton's proof of Kepler's law. There is, however, an equivoque in it, by the mixture of lines and areas in the union of the two last ratios, since $D^2$ is an area, and D but a line. The Editor, therefore, compares the actual areas as constant powers of the distance, and finds the periods to be $P^{\frac{\cdot 1}{1\cdot 5708}}$ to D, or P as $D^{1\cdot 5708}$; and then, by squaring both terms, for the mere sake of Kepler's form of expression, the ratio becomes $P^2$, as $D^{3\cdot 1416}$. This is not the place for such a discussion, but every reader will perceive the propriety of preferring a circular to a cubic ratio in such a subject. By this law, then, the distances of the planets from the Sun are determined, that of the Earth being known.

The Satellites are equally governed, like their primaries, which, as to them, have motions like the Sun, and similarly affect the medium of space. So, likewise, bodies on a planet are governed by its two-fold motions, and thereby carried, with force or weight, towards their own centres, in exact diagonals, of both motions, with a velocity *directly* as the progressive motion, and *inversely* as the rotative or deflecting motion; *i. e.* as 98062 feet in a second to 6024 feet, or 16·08725 feet to 1, which we know, by experiment, is the mean fall of a body. A similar principle of simultaneous progression and deflection leads to the compact consolidation of every planet.

It is this central force, and the great motions, acting variously on different densities and forms, primarily and secondarily, which produce all phenomena by action and reaction, and these can only become objects of our controul by being duly understood.

PLANTS, are organized bodies without voluntary motion, and consist of solid and fluid parts. To the former belong the cellular substance, the various vessels, the fibres and the pith; to the latter belong the sap and the various juices, as well as the air contained in plants. The air, the sap, and the juices have appropriate vessels. The *entire* or *proper* vessels, so called, are intended to contain the proper juices of the plant, and are generally found filled with oils or resinous juices. They are generally in bundles in the cellular part of the bark, and are found in the young shoots of almost every plant. The *spiral* vessels, so called from their appearance, are the largest of the vegetable vessels, and in many plants their structure is visible to the naked eye.

They are situated round the medulla of the young shoots of trees and shrubs. The *perforated* vessels are cylindrical tubes, the sides of which are said to be pierced with minute perforations. The fluid substances of plants move in the vessels and correspond in plants to *blood*, and may be compared with it as to functions. In a physiological respect, many points of correspondence between animals and plants are observable. Power of contraction, irritability, power of formation, power of reproduction, and other powers, are possessed by plants as well as by animals, though in a lower degree.

A tree of middling size evaporates daily about thirty pounds of moisture. As to the *odour* and taste of plants, they depend on the proportions of their elementary ingredients, and on the degree of heat to which the plant is exposed. Of the *colours* of plants, Senebier found that, when plants were put in a dark place, their green leaves become first yellow on the surface, and then white; whilst young plants which had grown up in the dark, when brought by him gradually to the light, exchanged their white colour for yellow, which, after a while, became darker, and showed by degrees green spots, continually increasing in number and size, so that, after some time, the parts before white acquired a perfectly green colour. Plants become lighter in consequence of combination with the oxygen which they inhale, darker if they lose it. The different proportion of oxygen to its other component parts gives the various gradations and shades. Saturation with oxygen gives the yellow and white colour. But, if a plant saturated with oxygen is exposed to the rays of the Sun, the substance of the light unites with the oxygen, the latter escapes, and the plant reassumes its green colour. For the rest, the colour seems to have its seat in the cellular substance.

The chemical analysis of plants shows that all vegetable matter consists chiefly of hydrogen, carbon, and oxygen. Their different proportions produce the variety of vegetable substances. Of these substances chemistry has distinguished *gum*, *fecula or starch*, *sugar*, *gluten*, *albumen*, *gelatin*, *caoutchouc*, *or Indian rubber*, *wax*, *fixed oil*, *volatile oil*, *camphor*, *resin*, *gum-resin*, *balsam*, *extract*, *tannin*, *acids*, *aroma*, *the bitter*, *the acrid*, *and the narcotic principles*, *and ligneous fibre*. Several of these substances are capable of transformation into each other. Thus the tasteless mucilage passes into sugar or acid. These changes are produced by heat, moisture, air, alkalies, which change more or less the proportion of the original constituents.

Plants have male and female organs of generation, which may be observed by the naked eye; yet these parts are generally not permanent, as in the case of animals, but change after fructification has taken place. The pollen or farina is prepared and preserved in certain vessels, destined for this purpose, called *anthers*. Its finest part penetrates through the stigma, an opening in the female part, through the pistil to the ovary, and fructifies the germs or ovules lying there.

With most plants both sexes are united in one flower; with a few they are separate. The former are called *perfect* flowers, the latter *male* or *female*. The two latter either stand on one stem, or belong to different plants. With the perfect flowers, fructification is effected most easily; and, also, where the same stem has male and female blossoms, no particular difficulty exists; but when the two sexes are entirely separated, fructification takes place only when the two plants of different sexes stand near enough for the pollen of the male plant to be carried to the female by the wind, or by insects. If this or an artificial fructification does not take place, the germ either falls off, or it forms a fruit, which is incapable of germinating. Grasses are generally fructified by the wind. Linnæus founded his sexual system on the generating organs of plants. He divided the whole vegetable world into twenty-four classes. The twenty-three first comprise the plants with visible blossoms, the *phanerogamous*. Of these, the thirteen first receive their names from the number of their stamens, or male organs of generation.

The fourteenth and fifteenth classes are determined by the situation of the filaments.

In the sixteenth, seventeeth, and eighteenth classes, the number of bundles in which the filaments are united determines the class.

*Diœcia* have entirely separate sexes, *i. e.* in which one plant produces only male, the other only female flowers.

*Cryptogamia* are all plants in which he found no sexual parts; but in many they have been since discovered, and even in those in which they are not yet known, they certainly are not wanting. It contains four orders:—1. ferns; 2. mosses; 3. sea-weeds, liverworts, lichens; and 4. fungi.

To this artificial system is opposed the *natural*, which is founded on the presence or absence of the chief organs, because plants differ from each other chiefly in this way.

The *primitive* form, which appears in the earliest stage, even of the smallest plant, is the globule, which we may observe even in the nourishing juice, which exudes from the inner bark *(liber)* of trees. These globules, becoming connected, form a texture of cellules, which is universally diffused through the vegetable world. The cellular texture serves for the preservation and preparation of the juices. Hence it is generally filled with mucilaginous, saccharine, oily, or resinous substances. The cellular texture, in the more perfect plants, has a remarkable connexion with the air. From the ferns upward, it becomes more regular towards the surface of the plant, and full of spaces, which are filled with air, received through apertures of a peculiar organization.

The *second* original formation is the rectilinear, fibrous, or, more properly, tubular structure. Powerful magnifiers show that the fibres are real tubes filled with juice, but not continuous, but here and there terminating in a point, in the liber of trees, also in the alburnum and in the nerves and ribs of leaves. Their first beginnings appear already in the mucilaginous nourishing juice, where they have the form of needles, and crystallize, as it were, in bundles. These tubes have the softest skin and the smallest diameter among all the original formations; yet they are extremely extensible and tough. They form what is spun as flax, and what is obtained for useful purposes from hemp, from the paper-mulberry, &c. Their chief purpose seems to be the conducting of the ascending juices.

The *third* formation is called the *spiralform*, because it consists primitively of fibres spirally wound, which form the sides of cylindrical canals. This formation appears, from the ferns upward, in the more perfect plants, surrounded by the vessels in bundles and single. In the trunk of common trees it generally forms the alburnum and the wood. With the palms, the grasses, &c. the spiral bundles are distributed in the cellular texture. The spiral canals pass through all parts. Through the leaf-stalk they penetrate with the vessels that convey the juices into the nerves of the leaves, through the flower-stalk into the corollæ, into the filaments, the ovaries, the pistils, even into the seeds.

The surface even of the firmest *roots* is surrounded with fine hairs, and the points are covered with a spongy cap, by which, and the hairs, the absorption of the moisture in the ground is carried on. A bundle of tubes passes through the centre of the root, in which there is no pith.

The *stem* consists in woody dicotyledonous plants of three distinct parts—the bark, the wood, and the pith.

The *bark* is composed of four parts, 1. a dry, leathery, tough membrane, the cuticle; 2. a cellular layer adhering to the cuticle, and called the *cellular integument*; 3. a vascular layer; and 4. a whitish layer, apparently of a fibrous texture, the inner bark, which is of a more complicated structure than the other layers.

The *wood* is at first soft and vascular, and is then called *alburnum*; but it afterwards becomes hard, and in some trees is of a density almost approaching that of metal. It is composed of concentric and divergent layers, the former consisting of longitudinal fibres and of vessels of various kinds, the latter of flattened masses of cellular substance, which cross the concentric layers. The individual cells are narrow and horizontal in their length, and extend in series from the centre to the circumference of the wood, so as to form nearly right angles with the tubes of the concentric layers. To carry on the functions of the wood, a new circle is annually formed over the old. The hardness of these zones increases with the age of the tree, those in the centre being most dense.

In the centre of the wood is *the pith*, enclosed by the medullary sheath. In the greater number of plants no vessels are perceptible in the pith. Little is known as yet with certainty, concerning its functions.

The majority of *leaves* are composed of three distinct parts, one firm, and apparently ligneous, constituting the frame-work or skeleton of the leaf; another, succulent and pulpy, fills up the intermediate spaces; and a third, thin and expanded, encloses the other two and forms the covering for both surfaces of the leaf. The first of these parts is vascular, the second cellular, and the third a transparent cuticular pellicle.

In *flowers*, the *calyx* is generally of the same construction with the leaves; but the *corolla* consists of the most delicate cellular substance, whose inner surface rises in the most delicate prominences. The spiral canals of a very small diameter pass singly through the lower part of the leaves of the corollæ, and no trace of apertures is to be discovered.

The *filaments* have a similar construction; but the *anthers* differ in construction from all the other parts. Entirely cellular they contain, from the beginning, a number of bodies peculiarly formed, called *pollen*.

The surface of the female *stigma* is covered with the finest hairs, which, without a visible aperture, receive the fructifying mass in the same organic way as the hairs of the root receive the moisture of the earth. The *ovary* contains, before the fructification, merely little bladders, filled with the nourishing juice. After the fructification, the future plant shows itself first in a little point which floats in that juice. Nourished by the latter, the little plant either swells and developes its parts, the cotyledones particularly becoming visible; or, if the juice is not entirely used up, it coagulates to a body like albumen, and the plant remains undeveloped.

Plants of different genera have similar qualities; thus Gray, in his admirable supplement, says there are *four greater carminative hot seeds:* anise, carui, ummin, and fennel.

*Four lesser hot seeds:* bishop's weed, stone parsley, smallage, and wild carrot.

Also *four cold seeds:* cucumber, gourd, melon, and water-melon.

And *four lesser cold seeds:* endive, lettuce, purslain, and succory.

Again, he gives to others a gumtuple affinity, as *five opening roots:* asparagus, Butcher's broom, fennel, parsley, and smallage.

*Five lesser opening roots:* caper, dandelion, eryngo, madder, and restharrow.

*Five emollient herbs:* beet, mallow, marsh-mallow, French mercury, and violet.

*Five capillary herbs:* hart's tongue, black, white, and golden maidenhair, and spleen wort.

*Four sudorific woods:* guaiacum, perfumed cherry, sarsaparilla, and sassafras.

*Four cordial flowers:* borage, bugloss, roses, and violets.

*Four carminative flowers:* camomile, dill, fever-few, and melilot.

*Four resolvent meals:* barley, bean, linseed, and rye.

Linnæus says, that *yellow* indicates bitter flavour; *red*, acid or sour; *green*, a crude alkaline taste; *pale-green*, insipidity; *white*, luscious; *black*, harsh, and nauseous. *Green* is most common, and *black* the most rare. No flower has its proper colour till in full bloom. Some change twice or thrice. Red changes into white and blue; blue into white and yellow; yellow into white; and white into purple.

*To revive plants, &c.*—Dissolve camphor in alcohol, adding the former until it remains solid at the bottom; a sufficient quantity of rain, or river water, is then to have the alcoholic solution added to it, in the proportion of 4 drops to 1 oz. of water. Plants which have been removed from the earth, and have suffered by a journey or otherwise, should be plunged into this camphorated water, so that they may be entirely covered, and in about two or three hours the plants revive. It is then to be placed in good earth, watered, &c.

PLANTAIN-TREE, a species of banana *(musa paradisiaca)*. The stem is soft, herbaceous, fifteen or twenty feet high, with leaves often more than six feet long, and nearly two broad. The spike of flowers is nearly four feet long, and nodding. The fruit is eight or nine inches long, and above an inch in diameter, at first green, but, when ripe, of a pale-yellow colour, and has a luscious, sweet pulp. It is one of the most useful fruits in the vegetable creation, and, as some of the plants are in bearing most of the year, forms the entire sustenance of many of the inhabitants of tropical climates. When used as bread, it is roasted, or boiled, when just full-grown; and, when ripe, it is made into tarts, sliced, and fried with butter, or dried and preserved as a sweetmeat. Three dozen plantains are esteemed sufficient to serve one man for a week.

PLANTATIONS, are the cultivation of trees on soils and situations not adapted to arable or pasture produce. The young trees are reared best in public nurseries, where the variety enables the farmer to select those which best suit his soil. Stiff land should be trenched two spits deep.

In *elevated situations* the larch, the Scotch pine or fir, the silver fir, the mountain-ash, and the birch, thrive best if planted young.—*Sinclair's Code.*

On *steep banks* ash and sycamore, or ash with willow, for underwood, answer profitably.

On *marshy soils* the birch, the alder, the ash, the willow, and the pitch-pine, grow luxuriantly. The last is strongly recommended in *the code.*

In *swamps*, after drainage and the mixture of calcareous earths, the best plantations are willows, fir, larch, poplar, or birch. Trees with tap-roots cannot thrive. An acre holds 20,000 roots of willows, from each of which six shoots may be cut every three years, or 120,000, worth from 10*s.* to 12*s.* per thousand.

On the *sea-coast*, the trees which answer best for shelter and ornament are the pinaster, the Weymouth pine, the Huntingdon willow, (a strong and rapidly-growing tree,) the evergreen oak, (called *quercus ilex*,) the Turkey oak, (*quercus cerris*,) the Demerara corsida, the plane or sycamore, the flowering elder, and, for strong hedges, the tamarix Gallica and Germanica, and the sea-buckthorn. Other trees, if protected when young, by banks of sods to windward.

On *good soils*, the oak, ash, Spanish chesnut, and elm, are properly preferred. The French willow, Canada poplar, wild cherry, and American live oak, are also valuable.

In bleak situations trees should be

planted in masses. Belts should be 50 or 60 yards wide. Waste corners of fields should be planted. In hedge-rows, they should be closely pruned to 15 feet high. The locust, acacia, and bird-cherry, bear transplanting at the greatest age. Plantations, including draining, cost about 5*l*. or 6*l*. per acre, and the enclosing from 10*s*. to 5*l*. In 30 years they are worth 30*l*.; 50 years, 80*l*.; besides the underwood from 20*s*. to 40*s*. per 100 bundles. Holes made for trees should lie open for a few weeks. An acre requires from 2000 to 4000 plants. In thinning, the stumps may often be left for underwood, but thinning should be early and frequent, and nurses removed in time. In pruning it should be remembered, that sap-wood never unites with heart wood, and hence the danger of close pruning in old trees.

Plantations, whether natural woods or artificial, are valuable when the soil is otherwise worthless. Chesnuts and larch, in 10 or 12 years, yield, for hop-poles, 100*l*. per acre. Cultivated forest-land often yields far less than the woods. The oak is the test, where that flourishes the land is best in cultivation, and where that will not grow best, in plantations.

Trees may be planted at all seasons. As soon as the trees are taken up, dip their roots in a puddle of cow-dung and loam, which preserves their fibres from the air. When adopted in the winter season, the plants may be sent to any distance, or kept out of the ground for weeks without the slightest injury; and they may be thus transplanted in the heat of summer with perfect success.

A 74-gun ship requires 3000 loads of timber, the produce of 50 acres, each tree 35 feet apart.

An acre of trees, in Wiltshire, was found to have on it 9 oaks, containing 2952 cubic feet; 20 chesnuts, 3182 feet; and 22 others, 280 feet; in all, 6414 feet, weighing, at 40 feet to the ton, 160 tons, or a ton to a perch.

In clearing lands in America, it is found that the roots of the maple and beech decay in four or five years. The oak in 10 or 12. Boring a hole through the middle hastens decay.

The finer branches of tanning ought to be performed with bark of mountain-ash, birch, and willows.

The salt spray destroys the sides of trees, to windward, on the coast.

In planting, the proportion is 3000 trees per acre, at four feet asunder; of these, 1000 should be oaks, 1000 larch, 500 spruce, and 500 beech. Plant larch, spruce, and beech, two and a half to three feet high; and oaks three and a half to four feet high, twice transplanted and well rooted, stout and clean.

For full information on these subjects we must refer to the two invaluable books *Young's Farmers' Kalendar* and *Sinclair's Code of Agriculture*.

PLASTER.—The consistency which plaster acquires is very variable, and the purest plasters are those which acquire least hardness. In some plaster it has been attributed to the presence of a few hundredths of carbonate of lime, but erroneously, for calcined plaster rarely contains free lime, and the addition of that base to those plasters, which have but little consistence, does not improve them. We must search for the difference of consistency, which is acquired by different plasters, when mixed with water, in the natural hardness which they possess in their natural uncalcined state. A hard plaster-stone, having lost its water, will acquire greater consistency when returning to its first state than a plaster-stone, naturally softer; since it is, in some degree, the primitive molecular arrangement which is reproduced.

We find, likewise, that when good fused steel has its carbon removed by cementation with oxide of iron, it will, by a new cementation with carbon, give a steel much more homogeneous and perfect than that obtained in the same circumstances by the cementation of iron.

In preparing quick-lime for plastering, it should be immersed in hot water, to make it work softer, and prevent blistering.

Plaster for Walls, in its roughest form, consists of loam, clay, hair, and lime, laid on with a trowel and hawk, and finished with lime, or white-wash. Fine stuff, or putty, is well-powdered lime, macerated with water, and evaporated to a strong consistence. With a fourth plaster of Paris, it makes guage stuff. Stucco is three clean fine sand and one lime, thoroughly mingled. Parker's cement is mixed with three sand. Hamlin's Mastic, the best of all, is mixed with linseed-oil and sand. The coats, one, two, or three, for different work, bear different technical names. The plasterer, also, nails on laths to partitions and ceilings. Rough-casting is effected, after two coats of plaster, with a mixture of clean small gravel and strong lime. Sized colours are used for painting plasters, but, for Parker's Cement, the colour is mixed with dilute sulphuric acid.

Plaster of Paris is prepared by burning and grinding gypsum. It is used by masons, by plasterers for mouldings, and by farmers for manure, and is the material of all casts in moulds, for which there is so large a demand in all countries. There are gypsum quarries in Leicestershire, Nottinghamshire, and Derbyshire.

*Warm* PLASTER is Burgundy pitch 9 and cantharides 1, melted. It relieves affections of the lungs, hooping-cough, rheumatic pains, &c.—*Or*, melt 1 lb. of Burgundy pitch, 2 oz. of yellow resin, and 2 oz. of yellow wax together, and 8 oz. resin of spruce fir, ¼ oz. of oil of nutmeg, with some olive-oil and water; or, take a sheet of caoutchouc and tie tightly on the part affected.

PLATE POWDER. — Mix 4 oz. of prepared chalk with 1 oz. of quick-silver, prepared with manna and chalk.—*Or*, 8 oz. of polisher's putty, 8 oz. of hartshorn, and 1 lb. of whiting.

PLATINA, is a metal of modern discovery, and owes its name to the Spanish word *plata*. Its ore, *native platina*, occurs in very small, irregularly-formed grains, of uneven surface, usually flattened, and having the appearance of being worn by attrition. It generally contains a little iron, and is accompanied, besides, by iridium, osmium, rhodium, palladium, and also by copper, chrome, and titanium. It is very refractory, and soluble only in nitro-muriatic acid. The pieces in which it occurs rarely exceed a few grains in weight. To procure the pure metal from its ore has been one of the most difficult problems in metallurgy.

The *Russian Method of rendering Platinum malleable* is as follows: the ore is first dissolved in aqua regia, in a retort with a recipient attached to it, with the aid of heat gradually applied: the duration of this digestion is indefinite.

The solution, finished, is, by means of a syphon, drawn off from the black sediment, and contains muriate of platinum, which, upon the evaporation of the liquid, remains in the form of a mass, showing some tendency to crystallization.

This mass is now dissolved in rain-water, and precipitated with sal-ammoniac. The precipitate presents the appearance of a yellow powder, being a muriate of platinum and ammonia, containing a small portion of iridium. This yellow precipitate is again clean washed and dried, and then, in a cast-iron pan, brought to a red heat, by which means the ammonia and muriatic acid are volatilized, leaving the platinum of a gray colour and in a metallic state, but combined with a small portion of iridium. Three pounds of this gray platinum are now ground in an iron mortar. The fine gray powder of platinum is now wrapped in paper, in order to keep it together, inclosed by a thick iron ring, placed upon an anvil, and, by the force of two men, slowly and gently pressed with a powerful screw-press into a compact mass. This cake is now again subjected to a red heat in a charcoal fire, and, being a second time placed under the action of the press, is very quickly, forcibly, and repeatedly pressed; and the platinum brought to a perfectly malleable state.

During the digestion, the osmium, or, at least, the greatest part of it, finds its way into recipient; the palladium and rhodium, with a small portion of iridium, remain in the black sediment. The portion of iridium which remains in the rain-water, after the precipitation of the platinum with sal-ammoniac, may be afterwards obtained, by evaporation, in the shape of small red crystals of muriate of iridium and ammonia; if these crystals be subjected to a red-heat, the ammonia and muriatic acid will be volatilized, and the pure iridium will remain as a gray powder. The osmium is not used in the arts; the rhodium and iridium form very good alloys with steel; and the palladium may, for many purposes, be used in the place of platinum. The iridium which remains in the platinum is not detrimental.

The round cake, or ingot of platinum, is now sent to the Imperial Iron Works, a few miles from St. Petersburgh, where it is passed between the rollers used for making bar-iron, and is thus rolled into thin bars; after which, that which is intended for coinage is taken to the mint, to be converted into ducats of the value of ten rubles each.

The mean specific gravity of the metallic cake of platina-powder, when taken from the press, is 10; that of the cake fully contracted by heat, before forging, is from 17 to 17·7; that after forging is about 21·25, and that of wire 21·5, being the maximum density of this metal. Pure platina has a white colour, very much like that of silver, but is inferior in lustre to that metal. It may be drawn into wires that do not exceed the 2000th part of an inch. It is a soft metal, and, like iron, admits of being welded at a high temperature. A wire one-tenth of an inch supports 590 lbs. without breaking.

Platinum melts before the oxy-hydrogen blow-pipe, and is dissolved in aqua regia, or nitro-muriatic acid. It forms 2 oxides, with 12 to 1 and 2 of oxygen.

Platina foil has been found of constant service in the experiments of chemists.

*To make Dobereiner's finely-divided Platina.*—Mix muriate of platina with a solution of neutral tartrate of soda in a glass tube, half or three quarters of an inch in diameter, and 20 or 30 inches in length, and apply heat until the fluid becomes slightly turbid; afterwards expose it for several days to the sun's rays. The greater part of the platina will separate from the solution, and be deposited in minute laminæ, of a grayish black colour, on the sides of the glass; the tube and its contents are to be put into a glass vessel containing water, and it is to be filled with hydrogen gas; the platina becomes almost immediately white, and shining like silver, and may then be readily detached from the glass. During the reduction of the platina, the tartaric acid is partly converted into carbonic and formic acids.

Spongy platina, for lamps for instantaneous light, is prepared of great power, by moistening the muriate of ammonia and platina with a concentrated solution of ammonia; the paste formed is to be heated to redness in an earthen or platina crucible.

PLEURISY *(pleuritis;)* an inflammation of the pleura, or membrane which lines the internal surface of the cavity of the breast, and covers the external surface of the lungs. The pleurisy is generally caused by colds, rheumatism, bleeding, &c. It comes on with an acute pain in the side, and is accompanied by a difficulty of breathing, attended with pain, by coughing, and feverish symptoms. At first the cough is dry, but is afterwards commonly attended with expectoration. The inflammation then disappears, but is sometimes succeeded by suppuration, and the lungs sometimes become attached to the walls of the breast. The disease is not dangerous in its first stages, and the application of leeches and blisters are recommended.

PLICA POLONICA, or the *Weichselzopf*, is generally preceded by violent head-aches and tingling in the ears; it attacks the bones and joints, and even the nails of the toes and fingers, which split longitudally. If so obstinate as to defy treatment, and ends in blindness, deafness, or in the most melancholy distortions of the limbs, and sometimes in all these miseries together. The individual hairs begin to swell at the root, and to exude a fat slimy substance, frequently mixed with suppurated matter, which is the most noisome feature of the malady. Their growth is, at the same time, more rapid, and their sensibility, greater than in their healthy state: and, notwithstanding the incredulity with which it was long received, it is now no longer doubtful, that, where the disease has reached a high degree of malignity, not only whole masses of the hair, but even single hairs, will bleed if cut off, and that, too, throughout their whole length, as well as at the root. The hairs, growing rapidly amidst this corrupted moisture, twist themselves together inextricably, and at last are plaited into a confused, clotted, disgusting-looking mass. Very frequently they twist themselves into a number of separate masses, like ropes; and there is an instance of such a *zopf* growing to the length of 14 feet on a lady's head, before it could be safely cut off. The hair, however, while thus suffering itself, seems to do so merely from contributing to the cure of the disease, by being the channel through which the corrupted matter is carried off.

The only known cure is to allow the hair to grow till it begins to rise pure and healthy from the skin, an appearance which indicates that the malady is over; it is then shaved off, and the cure is generally complete.

The *Weichselzopf* is not confined to the human species; it attacks horses, particularly in the hairs of the mane, dogs, oxen, and even wolves and foxes. Although more common among the poorer classes, it is not peculiar to them, for it spares neither rank, nor age, nor sex.

Though more common in Poland than elsewhere, it is likewise at home in Livonia and some other parts of Russia, and, above all, in Tartary, from whence, in fact, it is supposed to have been first imported during the Tartar invasion, in the end of the thirteenth centry.

PLOUGHS, are a double wedge of iron, held in the ground, and dragged through it by animal power, so as to turn up and over a certain breadth to the air. The old or *swing*-plough, lightly made, and drawn by two horses abreast, is still generally preferred. *Wheel*-ploughs are preferred by unskilful hands, and are useful in trenching and deep work. There are also the *trench*-plough and *double furrow*-ploughs. The Rotherham-plough has a straight mould-board, but those which are curved and of cast-iron are now preferred. Indeed, ploughs are now made entirely of cast-iron, with one wheel to govern the level. For deep work, or stiff clays, three or four horses or six oxen are needful. Steam-ploughs are recommended in the rage for that power.

PLOUGHING.—The holder guides the horses, if two, and makes the off-horse walk in the furrow made, and the near on the untilled ground, himself in the new furrow. The 4-fallow furrows should be from 10 to 7 inches wide, 7 to 5 deep. The seed-furrow 7 and 4. For crops, 8 and 9 inches by 4, 5, or 6. The depth depends on the soil and the previous crops. A working for the horses is four or five hours, according to soil. A pair of horses plough 3-4ths of an acre of light soil per day, and half of stiff soil. If the furrow-slide is 9 inches, an acre is 11 miles of furrows, without turnings, equal to another mile; for there are 6,272,640 square inches in an acre, and 77,440 squares of 9 inches in an acre, and this, by 7040, the number of

9 inches in a mile, goes 11 times. If the slide were 10 inches, the plough would travel 9·9 miles, and if 8 inches, 12·375 miles. Ploughing is, therefore, severe labour for men and horses. In spade culture, if a man turn over 7 inches each time, or 49 square inches, $\frac{6,272,640}{49}$ = 128,000 spades, to be turned in an acre. Cross furrows are practised on fallows. Ridges should be about 10 or 15 feet.

PLUMBAGO, or GRAPHITE, is sometimes found in thin, irregular, six-sided tables; but more generally in scales, or compact. Sp. gr. 2. It consists of carbon 96, and iron 4. Its most remarkable depositary is at Borrowdale, in Cumberland, where it exists in a bed of trap. The chief employment of plumbago is in manufacturing pencils and crucibles; the latter particularly, for the mint. It is also used for giving a gloss to iron stoves and railings, and for diminishing friction.

PNEUMATIC TROUGH.—This is an apparatus for collecting and examining aëriform bodies. Wine and beer glasses of various sizes; apothecaries' phials; cleaned oil flasks, with glass and tin tubes of various dimensions; old gun-barrels; tobacco-pipes; an argand and a spirit-lamp, with a common fire and bellows, offer inexhaustible resources to a person endued with the faculty of contrivance; especially if he can seal, and bend a glass tube over a lamp.

For the collection of gases, sparingly soluble in water, a white earthenware foot-bath, or a small washing-tub, may be employed. In this a shelf should be fixed. A glass, or metallic tube, proceeding from the vessel containing the substances from which the aëriform fluid is emitted, may then be laid under the edge of the jar, which, for this purpose, is permitted to project a little over the shelf; the gas will then rise into it in bubbles, and gradually displace the water. A gas may also be readily transferred from one vessel to another, by carefully reclining the glass which contains it under the edge of another filled with water, and projecting over the shelf; and they may likewise be removed from the bath, and transported from one place to another, by placing them in shallow vessels or saucers, and surrounding them with about an inch of water.—*See* GASES, OXYGEN, HYDROGEN, &c.

POISON, is any substance of which a small quantity, taken into the stomach, mixed with the blood by wounds, or through the lungs, or absorbed through the skin, can produce changes in the bodies of brutes or men, deleterious to the health, and even destructive of life.

In poisoning by acrid and corrosive substances, we use the fatty, mucilaginous substances, as oil, milk, &c., which sheath and protect the coats of the stomach and bowels against the operation of the poison. Against the metallic poisons, soap and liver of sulphur are most efficacious, as they prevent the operation of the poison by combining the alkali and sulphur with the corrosive particles of the metal. Oil, alkalies, and soap, are the best remedies for the powerful acids. For cantharides, mucilage, oil, and camphor, are employed. We oppose to the narcotic poisons the weaker vegetable acids, vinegar, the acid virus, coffee. Prussic acid is neutralized by alkalies and iron. To arouse those poisoned by opium, we use wine, coffee, brandy, camphor, &c.

There are four classes of destructive poisons: 1. Those which destroy the galvanic excitement of the brain and nerves, as alcohol or opium, in their various forms, which kill by syncope. 2. Those which enter the circulation, as arsenic, hemlock, Prussic acid, opium, henbane, nightshade, colchicum, &c. 3. Those which affect the spinal marrow, and produce paralysis, as *nux-vomica* and strychnus, which the legislature permits druggists to sell to many public brewers, killing by tetanic convulsions; and 4, those which act locally on the mucous membrane of the stomach and bowels, as corrosive sublimate, sulphate of zinc, nitrate of silver, oil of tobacco, cantharides, colocynth, elaterium, hedge-hyssop, strong acids and alkalies, which kill by gangrene. Each class has specific remedies, which are detailed by Orfila, Brodie, and Paris.

*Corrosive Poisons. Animal.* The blistering fly. *Mineral.* Ammonia, or volatile alkali. Arsenic. Corrosive sublimate. Lime. Muriatic acid. Muriate of antimony. Nitrate of silver—lunar caustic. Subnitrate of bismuth. Nitric acid—aquafortis. Oxalic acid. Solution of potash. Su phuric acid. Tartaric acid. Emetic tartar. Verdigris. White vitriol.

*Acrid Poisons*, are bryony root. Bitter apple. Gamboge. Hellebore, white, black, and fetid. Sow bread. Spurge. —*Arum; Croton Oil; Meadow Anemone; Meadow Narcissus; Ranunculus; Wolfsbane*; with nitre—saltpetre.

*Sedative*, or *Narcotic Poisons*, are Camphor. Hemlock. Henbane. Laurel-water. Opium. Prussic acid. Stramonium. Strong-scented lettuce. Tobacco, with carbonic acid.

*Acro-Narcotic Poisons*, are Coculus Indicus. Belladonna. Elaterium. Foxglove. Fool's parsley. Funguses. Meadow saffron. Nux vomica, with white lead:—*Sugar of lead; litharge.*

*Septic*, or *Putrescent Poisons*, are

Venom of snakes. Stings of insects. Fish poison. Bite of a mad dog.

*Corrosive Poisons* destroy the texture of the organ or part to which they are applied; and when this organ performs functions necessary for the preservation of the entire animal machine, or is a vital organ, death ensues. The most beneficial step to be taken is to empty the stomach, by means of the stomach-pump, or to solicit the evacuation of the poison from the stomach, by warm water or milk, containing white of egg, sugar, and magnesia, in large quantities.

*The blistering fly* is corrected by milk, solutions of gum, or of starch, and similar fluids, drank freely; the tepid bath, and starch clysters, with camphor. Oil dissolves the active principle of the blistering fly, and extends its influence.

*Ammonia, (Volatile Alkali,)* swallowed by mistake, is best corrected by vinegar or lemon-juice, which should be immediately given, and afterwards milk, and demulcent fluids.

*Arsenic* requires the evacuation of the stomach, by large draughts of tepid water, mixed with milk and sugar, or chalk and water, or lime-water.

*Corrosive Sublimate* requires large quantities of white of egg, diluted in water.

*Lime*, the same as for ammonia.

*Muriatic Acid*, or *(Spirit of Salt,)* requires directly calcined magnesia, mixed in any bland fluid.

*Muriate of Antimony*, or *(Butter of Antimony,)* requires large draughts of a strong decoction of yellow Peruvian bark, and previously diluents in quantities sufficient to excite vomiting.

*Nitrate of Silver, (Lunar Caustic,)* requires a strong solution of common salt, and then empty the stomach by an emetic, or by the stomach-pump.

*Subnitrate of Bismuth, (Flake White,)* requires large draughts of milk.

*Nitric Acid, (Aquafortis,)* requires a strong solution of soap, or calcined magnesia.

*Oxalic Acid.* (The taste of Epsom salts being bitter, and that of oxalic acid sour,) requires a mixture of chalk and water; and afterwards evacuate the oxalate thus formed, by an emetic, aided by copious dilution.

*Solution of Potash* requires vinegar or lemon-juice.

*Sulphuric Acid, (Oil of Vitriol,)* requires calcined magnesia in milk or water; or a solution of soap, or any of the fixed alkalies.

*Tartaric Acid* requires chalk and water.

*Tartar Emetic* requires a decoction of yellow Peruvian bark, or evacuate the poison quickly by encouraging vomiting with warm water, and allay the vomiting with a grain or two of solid opium.

*Verdigris*, in pickles, or from copper pans, requires large doses of syrup, or of sugar and water, until vomiting is produced by the bulk of the liquid: and afterwards give sugar or syrup in moderate doses.

*White Vitriol* requires milk freely.

*For Acrid Poisons.*—Empty the stomach by copious draughts of mucilaginous diluents, or by the stomach-pump; after which, vinegar, or lemon-juice, or any other weak acid, must be freely administered.

*Bryony Root.*—Excite vomiting, by tickling the throat, and large draughts of tepid water; after which, give milk, with from a grain to two grains of opium, once in two hours.

*Coloquintida. (Bitter Apple.)* Evacuate the stomach, and then administer milk and oil.

*Gamboge.*—Administer milk and other demulcent diluents, with a grain of opium at intervals.

*White Hellebore Root.*—Evacuate the stomach with copious draughts of demulcent fluids, and sheathe the bowels with clysters of starch; then administer freely acidulous drinks, coffee, and camphor in doses of from six to ten grains.

*Black and Fetid Hellebore*, as for bryony root.

*Sow Bread, (Cyclamen,)* as for white hellebore.

*Spurge.*—First evacuate the stomach by large draughts of tepid water; and then give repeatedly olive-oil and milk, sheathing the lower bowels with starch clysters.

*Nitre, (Saltpetre.)* Dilute freely with milk and bland diluents.

*Sedative and Narcotic Poisons* cause drowsiness, stupor, paralysis, or apoplexy, convulsions, and death.

*Camphor.*—Give wine in moderate quantities with ten or fifteen drops of laudanum, at short intervals.

*Hemlock, (Conium maculatum.)*—The stomach should be first evacuated by the stomach-pump, or by a scruple of white vitriol, and acidulous fluids afterwards freely administered.

*Henbane*, as for hemlock.

*Laurel Water.*—Brandy, containing in each glass from fifteen to thirty drops of solution of ammonia, or a tea-spoonful or two of hartshorn, at short intervals, until the influence of the poison is overcome.

*Opium.*—Dislodge the poison, either by the stomach-pump, or by an emetic consisting of a scruple of white vitriol, or from five to eight grains of blue vitriol: and by irritating the upper part of the gullet and the throat by the finger or with a feather. After the stomach is emptied, give freely acidulous fluids, with strong coffee and cordials, and immerse in a tepid bath.

*Prussic Acid*, as for laurel-water.

*Stramonium*, (*Thorn Apple*,) as for opium.

*Tobacco*.—Clear the stomach by two or three grains of tartar-emetic; but, if some time has passed, administer purgatives, and afterwards acidulous drinks, with brandy, camphor, and cordials.

*Carbonic Acid Gas.*—When suspended animation occurs from this gas, remove the body into the open air; and while friction is applied over the chest, let the lungs be inflated by means of a pair of bellows, closing and opening the nostrils and mouth alternately, and pressing on the chest after each inflation, so as to imitate, as nearly as possible, the action of breathing. Hydrogen gas is to be counteracted in like manner.

*Acro-Narcotic Poisons. — Cocculus Indicus.*—Vomit and purge freely.

*Deadly Nightshade*, (*Belladonna.*)—The sweet taste of the berries often allure children to eat them. The symptoms resemble those of intoxication, with high delirium, accompanied with laughter, and paralysis of the stomach. Administer vinegar and acidulous drinks, which often enable the emetics to operate; and continue the use of the acids until all the symptoms disappear.

*Elaterium*.—Support the strength by cordials and opium, in doses of a grain, repeated at short intervals; and exhibit clysters of starch, with from 40 to 60 drops of laudanum in each clyster.

*Foxglove*, (*Digitalis.*)—Administer brandy and cordials.

*Fool's Parsley*.—Evacuate from the stomach by large draughts of demulcent fluids.

*Funguses and Poisonous Mushrooms.*—Evacuate the stomach by emetics and purgatives, or by a combination of the two: as, for example, a scruple of powder of ipecacuanha, and two ounces of Glauber salts; after which, give acidulous drinks with brandy, or a tea-spoonful of æther at short intervals: and, lastly, Peruvian bark. Ammonia and hartshorn are hurtful.

All funguses which grow in damp, shady places, which have a porous, moist, dirty surface, a disagreeable aspect, a fœtid odour, a gaudy colour, soft, open, and bulbous stalks, and grow very rapidly, and corrupt quickly, are to be suspected.

*Meadow Saffron*, (*Colchicum.*)—Evacuate the stomach by copious draughts of demulcent fluids; then give from six to ten grains of ammonia, or a tea-spoonful, or two tea-spoonfuls of hartshorn, in a glass of brandy at short intervals.

*Nux Vomica*, (*Ratsbane.*)—Evacuate the stomach and bowels; and afterwards dilute freely with acidulous fluids.

*White Lead*, (*Carbonate of Lead*,) or *Sugar of Lead* and *Litharge*.—Administer an ounce of castor-oil with 40 drops of laudanum, and put the patient into a warm bath.

*Septic or Putrescent Poisons.—Venom of Serpents*, such as the *Viper*, the *Rattlesnake*, and *Cobra de Capello*.—Put a ligature upon the limb which has been bitten, between the wound and the trunk of the body, and apply a wine-glass, exhausted by burning a little spirit within it, as a cupping-glass over the part, or let the wound be sucked by a person whose lips and tongue *are not chapped*; for if the lips or the tongue of a person who sucks a poisoned wound be chapped, the system is inoculated in the same manner.

*Stings of Bees, Wasps, and other Insects.* Bathe the affected parts with tepid spirit of mindererus.

*Fish Poison*.—Evacuate the stomach by a powerful emetic, and the bowels by a purge; after which, administer copious draughts of acidulated fluids, with from 20 to 40 drops of æther at short intervals.

*Bite of a Mad Dog*.—Tie a ligature above the wound, and apply a wine-glass or a cupping-glass over it, until a good surgeon can be procured to cut out the bitten part. When the disease appears, cup the patient over the course of the spine, and administer small doses of Prussic acid.

Symptoms of *cholera morbus*, *diarrhœa*, *malignant fever*, and several other diseases, may be mistaken for those of poison; and, hence, the necessity of immediately procuring medical assistance.

There is a method of ascertaining the presence of minute quantities of metallic poisons. It consists of small slips of different metals, generally zinc and platina, placed in contact, and forming a galvanic circuit with the interposed fluid suspected to contain the poisonous metal; in which case, the metal held in solution is deposited in the form of crystals, on the negative surface. The zinc is usually employed in the form of foil; the platina is, in some cases, a small crucible, or a spatula, but more frequently platina foil is used. It is generally necessary to mix a few drops of acid with the metallic compounds that are subjected to this test, and that are placed in contact with the platina; on applying the zinc foil, the platina will soon become coated with the reduced metal. Dr. Davy was enabled to detect the presence of arsenic, by the exhibition of its characteristic properties, when only the 500th part of a grain of that metal was deposited.

POLISHING METALS.—The workmen commence by preparing the surfaces of the articles; that is to say, it is of importance to remove all the marks left by the file, the turning tool, the scraper, &c. in order to render the surfaces uniform.

This preparation is effected on those metals, which are not very hard, by means of pumice-stone, either used in substance, or reduced to powder, and water; and, when in powder, applied upon felt, or upon slips of soft wood, covered with buffalo or chamois skin, if the surfaces be flat; or with pieces of soft wood, properly shaped, so as to penetrate into the hollows, and act upon the raised parts. When the first coarse marks are thus removed, they then proceed to remove those left by the pumice-stone. In order to this, they employ finely-powdered pumice-stone, which they grind up with olive-oil, and employ it upon felt, or upon small pieces of soft wood, such as that of the willow or sallow. It is important, in these manipulations, to observe an important rule, which is never to proceed from one operation to another, before previously washing the pieces of work well with soap and water, by means of a brush, in order entirely to remove the pumice-stone, used with water, before employing it with oil, and likewise never to use those tools for succeeding operations, which had been used in preceding ones; each stage of the operation requiring particular tools, and which should be kept in closed boxes, in order to prevent the powders from being diffused or scattered about when not in use.

After removing the marks left by the coarse pumice-stone and water, by means of finely-grounded pumice-stone and oil: to know which, we should wash it with soap and water, and dry it well with a linen cloth: we must then examine it with a lens or magnifying-glass, to see whether any scratches yet remain; if not, we may proceed to the polishing. The softer metals are polished in different manners, according to their size and uses; the larger gold works are, however, generally burnished, but the smaller gold works in jewellery, &c. and those in brass for watch-work, are not burnished, but polished. The following are the manipulations:—After having removed with oil-stone powder the marks of the file, &c. they smooth them with blue and grey stones, and plenty of water: there are two kinds of these stones, the one soft and the other hard; the first argillaceous schistus, the second kind schisto coticule; this serves to sharpen tools upon. The pieces of watch-work are always smoothened in this manner, until all the marks disappear, and which is known by washing them with soap and water.

They finally proceed to polishing with the tripoli from Venice, which is preferable to any other sort, and is either finely ground in water, or in olive-oil, according to the different cases, for pieces of gold-work, or the larger kinds of jewellery articles, and until they perceive their surfaces are become perfectly brilliant; they then finish them with tripoli, reduced to an impalpable powder, and applied upon a very soft brush.

For polishing those pieces of watch-work which are not to be gilt; after smoothing them with grey or blue-stone and water, they polish them with rotten-stone well washed over, and consequently very fine, ground up with olive-oil, and finish them with dry rotten-stone.

This rotten-stone is a kind of very light tripoli, but finer and more friable than the other sorts. It is found in England, and is highly esteemed for polishing; it is of an ashy-grey tint, and occurs in thin layers, upon the compact carbonate of lime, near Bakewell. The polishing of steel is not executed in the same manner as in polishing the softer metals; the steel is not polished until it has been hardened, and the harder it is the more brilliant will be its polish. The substances above indicated for polishing other metals are not powerful enough to attack a substance so hard as this. We must employ emery ground in oil, before used. Hardened steel is either polished flat, like glass, or cut into facets, like a diamond; consequently, the lapidary's mill is used. They commence by smoothing the work with rather coarse emery, then with finer emery, and finish with the finest. The smoothing being perfected, they polish it with English rouge, tritoxide of iron, and oil, and finally finish it with putty of tin (peroxide of tin) and water; but if upon mills, or laps of zinc, then without the use of water. When the steel articles consist of raised and hollow work, they are smoothed and polished with the same substance; but the instruments are, as in the case of less harder metals, pieces of wood, properly shaped, and employed in the same manner. The finish at Sheffield is effected with the female hand.

*Polishing Ivory, Bone, Horn, and Tortoiseshell.*—Ivory and bone, either plain or ornamented: and ivory or bone articles admit of being turned very smooth, or, when filed, may afterwards be scraped, so as to present a good surface. They may be polished by rubbing them first with fine glass paper, and then with a piece of wet linen cloth dipped in powdered pumice-stone; this will give a very fine surface, and the final polish may be produced by washed chalk, or fine whiting applied upon another piece of cloth wetted with soap-suds.

*Horn and Tortoiseshell.*—A very perfect surface is given by scraping them; the scraper may be made of a razor-blade, the edge of which should be rubbed upon an oil-stone, holding the blade nearly upright all the while, so as to form an edge like that of a currier's knife; and which, like it, may be sharpened and improved by burnishing, at least as far as its hardness will permit. To prepare the work, when properly scraped for polishing, it is first to be rubbed with a buff, made of woollen cloth, perfectly free from grease. After the work has been made as smooth as possible by this means, it must be followed by another buff or bob, on which washed chalk or dry whiting is rubbed; the comb, or other article, is to be slightly moistened with vinegar, and the buff and whiting will produce a fine gloss, which may be completed by rubbing it with the palm of the hand, and a small portion of dry whiting or rotten stone.—*Gill's Repository.*

*Polishing Iron, Brass, &c.*—A beautiful surface is produced upon cast-iron, steel, and brass-works, by means of emery sticks, and others coated with crocus. Mix drying linseed-oil, in the proportion of one-eighth part with his glue, and coat the surfaces of pieces of soft yellow pine, fir, or deal, without turpentine or knots, which are about eight inches long, and five-eighths of an inch square, and nicely planed. Lay on a coat of thin glue, and when that is dry, another composed of glue mixed with the emery or crocus, and then instantly sift over the wet surface the emery or crocus in powder, by means of a sieve. Emery is employed of different degrees of fineness, and sticks thus coated with each may be used in succession, to smoothen the work; and, lastly, sticks coated with glue and crocus are used to give the finishing polish. Such emery and crocus sticks are very durable, and are equally useful on works in the lathe, as well as upon flat surfaces; are superior to the glass or emery papers ordinarily used; and greatly to emery mixed with oil, and applied upon sticks in the common way.

*Hindoo Polish.*—Powdered corundrum with melt lac is used to polish all stones, first sprinkling them with water.

*German Polish.*—The wood is prepared with pumice-stone rubbed flat, oiled, and then rubbed together till smooth. The only varnish then used is a solution of seed-lac or shell-lac in alcohol, the clearest grains of lac being for the lightest varnish. It is coloured red with Brazil wood, and yellow by turmeric root. It is applied with a rubber of five pieces of linen; the varnish is put on with sponge, and having soaked through the linen layers, a little linseed-oil is added in the midst of the varnish, and the whole extent of the surface of the article to be polished must be then gone over at once with this rubber.

POMATUM, (*à la rose.*) Melt 1 lb. of lard, and 4 oz. of suet, and add 1 oz. of rose-water, and 1 oz. of spirit of roses. *Or*, (*Divine.*) Beef-marrow 24 oz. with 1½ oz. of cinnamon, and 1 oz. of each of storax, balm, benjamin, and iris root, and 1 dr. of cloves and of nutmegs. *Or*, melt, by gentle heat, mutton suet 24 oz. and mix, in 9 drs. of each, of storax, balm, benjamin, iris and cypress roots, cinnamon, cloves, and nutmegs; strain. *Or*, marrow 2½ lbs. balsam of Gilead 3 oz. and 1 oz. of oil of cloves. *Or*, melt together 1 lb. of white wax, and 4 lbs. of mutton suet, and add 1½ oz. of essence of bergamot and of essence of lemons, and 4 drs. of oil of lavender, and of oil of thyme. The last oil is peculiarly promotive of the growth of hair.

*Pomatum Scent.* Mix together 7 oz. of oil of lavender, half an oz. of oil of cloves, 1 oz. of oil of thyme, and add 10 oz. of gum benjamin. *Or*, mix 6 oz. of essence of bergamot and of essence of lemons, 1½ oz. of oil of cloves and of thyme, 1½ oz. of oil of orange-flowers, (or neroli.)

POPPY, white, the source of opium, an annual planted in April and the capsules bleed in July. It should be in wide drills with a light sub-soil. The bleeding is effected by a vertical incision with a double-edged knife, narrowed by sealing-wax, a few days after the flowers fall. A brush called a sash-tool collects the juice. An acre will yield 50 lbs. of opium, 375 lbs. of oil, and 500 oil-cakes, worth 120*l.* and the cost 60*l.* Large quantities of capsules are grown at Mitcham, but much opium is brought from the Levant and India.

POROSITY, is an essential property of bodies, and is best ascertained by the microscope, which shows us the passage of fluids through solid bodies. Air may be blown, by the mouth, in a profuse stream, through a cylinder, two feet long, of dried oak, beech, elm, or birch; and if a piece of wood, or a piece of marble, be dipped in water, and submitted to experiment under the receiver of a pneumatic machine, the air issuing through the exterior cavities will appear in a torrent of bubbles on the external surface. In like manner mercury is forced through a piece of dry wood, and made to fall in the form of a shower. If a few ounces be tied in a bag of sheep-skin, it may be squeezed through the leather by the pressure of the hand, in numerous minute streamlets. This experiment illustrates the porosity of the human cuticle. From microscopic observations, it has been computed that the skin is perforated by a thousand holes in the length of an inch. If we estimate the whole surface of the body of a middle-sized man to be 16 square feet, it must contain no fewer than 2,304,000 pores. These pores are the mouths of so many vessels, which perform that important function in the animal economy, *insensible perspiration.* The lungs discharge, every minute, six grs. and the surface of the skin from three to twenty grs., the average over the whole body being fifteen grs. of lymph, consisting of water, with a very minute admixture of salt, acetic acid, and a trace of iron.

PORPHYRY, is a compound rock, having a basis in which the other contemporaneous constituent parts are imbedded. The base is sometimes claystone, sometimes hornstone, sometimes compact feldspar, jade, pitchstone, pearlstone, and obsidian. The imbedded parts are commonly feldspar and quartz; the former in more or less distinct crystals. There are porphyries of different ages. One variety is found graduating into granite and gneiss; but this does not possess the characteristics of the rock in the highest perfection; another is found in overlying strata, and unconformable to other rocks, which is the true porphyry. Its color is often red or green, and, when polished, is valuable for ornamental work.

PORT WINE.—The wine country of the Upper Douro begins at about 50 miles from Oporto. The better wines, under the name of *factory* wines, are destined for exportation; those designed for the English market are called *vinhos de embarque*, or *export* wines, and those for other countries *vinhos separados*, or *assorted* wines. The wine is first placed in large tuns, in which it remains till winter, when it is racked into pipes, and conveyed to Oporto. To that intended for exportation, brandy is added, when it is deposited in the stores, and an additional quantity when it is shipped, generally about a year after the vintage. It is then of a dark purple color, a full body, with an astringent bitter-sweet taste, and a strong flavor and odour of brandy. After remaining some years in the wood, the sweetness, roughness, and astringency of the flavour abate; but, it is not until it has been kept 10 or 15 years in bottle that the odour of the brandy is subdued, and the genuine aroma of the wine is developed. When a very large portion of the extractive and coloring matter is precipitated in the form of a crust, the wine becomes tawny, and loses its flavour and aroma. This is very apt to be the case in the wines made from white grapes, and colored with elder-berries or other materials—a common practice when there is a deficiency of the black grapes. Port wines of excellent quality are often so highly adulterated with brandy as to be entirely deprived of their flavor and aroma; and the stronger kinds, which are not irretrievably ruined by this admixture, only regain their flavor after being allowed to mellow for many years.—*See* WINE.

PORTLAND POWDER, once considered a specific for the gout, is made of equal parts powdered and mixed of the roots of gentian and berthwort, the tops and leaves of germander, ground pine and lesser centaury.

POTASH, a well-known alkali, is made by burning fumitory, wormwood, fern, &c. cut before the seed-time, burned, and the ashes well-washed in 12 times the weight of boiling water.—The decanted solution is then evaporated to dryness in iron pans; and the dark-coloured salt exposed in a reverbatory furnace, without being burnt, and it then becomes pearl-ash.

| | |
|---|---|
| 1,000 wormwood yields .... | 748 lbs. |
| 1,000 fumitory yields ....... | 360 |
| 1,000 stalks of sun-flowers .. | 349 |
| 1,000 vine branches ......... | 163 |
| 1,000 stalks of Indian corn .. | 198 |

Beech, elm, fir, heath, &c. yield 10 or 12 per cent.

Kelp, barilla, and other marine vegetables, after being *burnt* yield alkali, as soda; and other vegetables, woods, &c. yield *potash*—and it is said that if these are grown on soil manured with sea-salt, soda also is their product.

When potash is put into a solution of salt and water, the salt is decomposed, for the muriatic acid of the salt unites with the potash, and the soda is, therefore, disengaged, though not precipitated.

Potash may be obtained also from potato-tops, before they flower.

It may also be made from cream of tartar, the crystallized deposits of wine casks, by burning it black in a crucible, then washing with water, and the decanted solution evaporated to dryness is carbonate of potash. Then, if this be boiled with its own weight of lime in five times their weight of water, it becomes a white cake of alkali, fit for soap-making and other purposes. It should be kept closely stopt from air, as it becomes oil of tartar.

Its chemical name is hydrate of potash. A solution of it dissolves the oxides of lead, tin, zinc, antimony, arsenic, &c. It operates like other alkalies and negative electricity in changing the purple infusions of cabbage and violets to green, the red acidified infusion of litmus to purple, and the yellow of turmeric to bright brown.

When potash is burnt with a small portion of charcoal, at a moderate heat it produces both carburetted hydrogen and mild sub-carbonate of potash; but with great heat it produces carburetted hydrogen, carbonic oxide, and, if received in naptha, through a wide tube, potassium passes over.

One of its compounds with nitric acid is *saltpetre*.

*Saltpetre, rough*, is an efflorescence from stones and the rubbish of old buildings, and obtained by lixiviation, adding wood ashes to supply the alkaline basis. It is refined by dissolving it in water and crystallizing.

*Sore-throat salt* is *Salprunellæ*, made by melting 1 lb. nitre, and injecting upon it gradually flowers of sulphur 2 oz., and pouring it out into moulds, either as balls or cakes.

*Muriate of potash, Hydrochlorate of potash*, is made by saturating spirit of salt with pearlash, evaporating and crystallizing. *Or*, by heating or distilling sal ammoniac and pearlash, dissolving the residuum in water, evaporating, and crystallizing.

*Oxymuriate of potash*, (*Chlorate of potash.*) Mix common salt 3 lbs. manganese 2 lbs. and add oil of vitriol 2 lbs. previously diluted with water, then distil into a receiver containing 6 oz. of pearlash dissolved in 3 lbs. of water. When the distillation is finished, evaporate the liquid in the receiver slowly in the dark: the oxymuriate will crystallize first in flakes. It explodes when struck, or dropped into acids, and is used for making matches for instantaneous lights, and for procuring oxygen.

POTASSIUM, is the metal of which potash is considered the oxide. It is made either by calcining cream of tartar with some charcoal, or by exposing potash to the violent action of the poles of a galvanic battery, by which it is considered that the oxygen of the oxide is drawn off, and the oxide reduced to the pure alkaline metal potassium. It however so readily absorbs the oxygen, as only to be preserved in naptha, and by absorbing oxygen from water burns on it and returns to potash.

The restoration at the poles of the battery is not considered as imparting any of the galvanic principles, but merely operating on the atoms so as to detach the oxygen which forms the oxide or alkali.

Potash and the other alkalies are therefore assumed to be oxides of the metals, made from them by like means, and then the metals oxidate again, and return to potash, soda, lithia, barytes, strontian, calx, and magnesia, again losing their metallic names in *um*.

Potassium is but ·862 sp. gr. and sodium is but ·972.

In detailing the galvanic reduction of these alkaline oxides, Davy mystified himself by his obscure ideas about the nature of galvanic action. He evidently supposed that it imparted some virtue or elementary principle to them, and hence, as a sequence, he invented his electro-theory, quoting this phenomenon. The attraction of the negative pole was spoken of with emphasis, and there are few of his readers, even to this day, who understand the fact that the decomposition of the alkaline oxides was a mere excitement, and, at most, only aided by the oxygen of the positive pole and the nitrogen of the negative pole. For, in passing through coloured solutions, we know their effects as acid and alkaline, and, in passing through an alkaline oxide, there would be such an effect on both principles as would loosen their affinities, and separate one from the other by the mere force of protrusion. The disturbance of the oxygen would, by mere reaction, also carry the metal to the negative pole.

All the modern theories err in their inferences about the conversion of potash into potassium and of potassium into potash. Potassium is pure alkalinity, such that, as alkali, it cannot exist in the oxidated atmosphere. So much oxygen then combines as fits it for endurance, and it is then potash again. The sole effect of the galvanic charge was, by its intense motion, to disturb the union of oxygen and nitrogen in the piece of intervening potash, by which the dose of oxygen in the potash was dispersed, and its purity as alkali restored in the potassium.

All the mistakes have arisen from its being supposed that the galvanic shock communicated something to bodies in its passage; but it cannot be too often repeated that all the visible and sensible phenomena of electricity are nothing more than the mechanical restoration of a disturbed condition of oxygen and hydrogen, or nitrogen, at the seat of excitement. Of this restoration intermediate bodies may, by obstruction, be the patients, and may be wholly or partially dispersed, but they receive nothing and cannot receive, since the sole object is the re-union of *exact* equivalents of positive and negative electricity, and of no more than the even and exact equivalents of each. For whatever may happen at the place of restoration, to which the disturbance has been translated, it is subordinate to the origin of the excitement at the seat of excitement; and, as each side creates the other side, one cannot pass off by itself. In fact, the restoration is correlative motion, or, as to intervening objects, mechanical force.

All that takes places in electricity and in galvanism are exactly similar. There is the central excitement, the two spheres, their centres, the wires, the translation, the virtual union of the centres by the wires, and the atomic excitement of the piece of potash, such as to disperse its oxygen, and afford a specimen of evanescent alkalinity in the potassium placed in air.

*Caustic Potash.*—If one part of carbonate of potash be dissolved in four parts of water, and the solution be boiled with slacked lime, the potash does not lose the smallest quantity of carbonic acid; it does not become caustic, even though lime be added to any extent, or however long the boiling may be continued. If, however, six parts of water be gradually added to the above mixture, it will be found, and without further boiling, that the potash loses its carbonic acid gradually; and that, after the addition of the last portion of water, the potash is perfectly caustic. If the water be added at once, the potash becomes very quickly caustic.

*The water of Caustic Potash* is made by dissolving 1 lb. of sub-carbonate of potash in two pints of water and half a ℔. of unslacked lime in six pints. Cool and filter, and if effervescing with acids add more lime. A pint should be an avoirdupois pound, or to distilled water as 27 to 25. It is much used in pharmacy, and is diuretic, anti-acid, and a dissolver of stone. It is given in small doses in milk or barley-water.

*Acetate of Potash* is a still more powerful diuretic, in doses of 1 scruple to 3. It is made by boiling carbonate of potash in acetic acid, and adding till no effervescence. Then dissolve in water, filter, and crystallize, keeping in closed bottles. It is white, and soon deliquesces in air.

*To make carbonate of potash*, mix equal weights of white pearl-ashes and water, triturate them and macerate for 7 days. Filter, and evaporate to dryness, constantly stirring. Then preserve in close bottles.

*To make sub-carbonate of potash*, dissolve 3 lbs. of pearl-ashes in 3 lbs. of boiling water, and in an iron pot evaporate and stir to thick consistence. It is used for saline draughts, with cetric acid or lemon-juice.

Pure potash consists of 14 oxygen, combined with 86 potassium, per Davy; but the hydrate is 84·2, potash, and water 15·8, or 40 potassium, 1 oxygen. Potassium is 0·865, sp. gr. and hydrate of potash 1·7085, or nitrate 1·933.

100 subcarbonate of potash neutralizes 70 concentrated sulphuric acid.

In burning potassium in oxygen, (when it displays no want of hydrogen,) every grain absorbs 1·7 cubic inch of oxygen, or 0·576 grains, or nearly 2-3ds.; but when in contact with water, if there is no mistake in reasoning upon the fact, the potassium absorbs oxygen, and decomposes the water, so that 1 gr. of potassium generates 1·185 cubic inches of hydrogen, *i. e.* it has also fixed 0·5925 cubic inches of oxygen, or 0·2 of a grain, by weight, or 1-5th of the potassium.

POTATOES, CULTURE OF.—The following sorts will produce a succession of good potatoes for the year, without artificial means:—

| | |
|---|---|
| May, June, and July ........ | Ash-leaved, red, and other kidneys. |
| July and August ............ | Purple eyes; a fine, large, round, mealy potato. |
| September, October, and November .................. | Prussian; a red, mealy potato. |
| November, December, and January .................. | Devonshire apple, Prince's beauties. |
| February, March, April, and May ...................... | Red colliers, and white long-keepers. |

Double-dig the ground, and, without manuring, plant the potatoes, whole, two feet apart each way. When the plants rise, hoe and draw the earth up to them, moulding entirely round each plant, by which mode all have room to swell and bring their tubers to perfection. The soil is not much exhausted by this practice, and the potatoes are easily got at so as to mould them up, even in their last stage of growth. Pick off the blossoms, which adds to the produce one ton per acre. Spaces between trees can be profitably used without detriment to them, and from the way the potatoes are moulded round, whatever rain falls in a dry summer, it is quickly conveyed to the roots of newly-planted trees.—*Jessop.*

*New kinds of Potatoes from Seeds.*—Sow the seed in a hot-bed, about the middle of February, in lines 6 inches apart, a quarter of an inch deep, and very thin. When water is necessary, sprinkle it between the lines. A little air must be given before they are watered. As the plants rise, rich earth should be carefully put between the lines; but the tops of the plants must not be covered. About the end of April they must be refreshed with air; and, two hours before removing them, they must be watered *all over*. Take each plant up carefully, with a ball of earth attached to it, and plant them in trenches, as celery, and the distance from plant to plant in the lines must be 18 inches. Earth up occasionally, as long as the space between will admit. The best manure is yellow moss and rotten horse-dung.—*Macartney.*

*Early Potatoes.*—Put the potatoes in a room, or other warm place; about the 2d of February cover them with a woollen cloth for four weeks, then take it off. Towards the latter end of March set them, covering the sprouts about two inches deep. If the sprouts be about two inches long, when set, the potatoes will be ready in seven or eight weeks.

*Or*, Place the potatoes in a green-house, in turf mould, or peat earth, in the beginning of February, and keep them well moistened with water; plant them in the open air about the end of March, on a warm border, leaving about half an inch of the points of the sprouts above the ground, and protect them during nights by coverings of mats. By this plan, you have new potatoes about the beginning of May. Get them well sprouted before they are planted.

Mr. Knight recommends potatoes to be planted very close in rows, but the rows very distant from each other.

*The Everlasting Potato* affords a supply of early potatoes, from one end of the year to the other. They are left undisturbed, except when a dish is wanted; they are not deeply embedded, but soon discovered on stirring the surface mould. The flower is different from that of the common potato. They should be planted about the latter end of May. Before frost sets in the bed is covered with litter, as a protection. They are taken up at Christmas as fine new potatoes, and are either suffered to remain undisturbed, or, perhaps, what is still better, the potatoes are forked up as they are wanted, and the smallest being separated are set apart for seed, under a heap or hillock. The smallest sprig will grow.

Mr. Knight, President of the Horticultural Society, gives an account of the result of his experiments in raising new varieties of potato from seed, and in growing crops in different soils and situations. He raises new varieties from seeds, chiefly by the aid of artificial heat, by which means he obtains, within the first year, a specimen of the produce. He says: "In raising varieties of the potato from seeds, it is expedient to use artificial heat. I have trained up a young seedling plant in a somewhat shaded situation in the stove, till it has been between 4 feet and 5 feet high, and then removed it to the open ground in the beginning of May, covering its stem, during almost its whole length, lightly with mould; and by such means I have obtained, within the first year, nearly a peck of potatoes from a single plant. But I usually sow the seeds in a hot-bed early in March, and, after having given them one transplantation in the hot-bed, I have gradually exposed them to the open air, and placed them out in the middle of May: and, by immersing their stems rather deeply into the ground, I have, within the same season, usually seen each variety in such a state of maturity as has enabled me to judge, with a good deal of accuracy, respecting its future merits. I stated, in a former communication, two years ago, that I had obtained from a small plantation of the early ash-leaved kidney potato, a produce equivalent to that of 665 bushels, of 80 lbs. each, per acre; and my crop of that variety, in the present year, was to a small extent greater. By a mistake of my workmen, I was prevented ascertaining, with accuracy, the produce, per acre, of a plantation of Lankman's potato: but one of my friends having made a plantation of that variety, precisely in conformity with the instructions given in my former communication to this Society, I requested that he would send me an accurate account of the produce; which I have reason to believe he did, for its amount very nearly agreed with my calculation upon viewing the growing crop, about six weeks before it was collected. The situation, in which this crop grew, was high and cold, and the ground was not rich; but the part where the potatoes to be weighed were selected was perfectly dry, and afforded a much better crop than the remainder of the field, which was planted with several different varieties. I calculated the produce of the selected part to be 600 bushels per acre; and the report I received, and which I believe to have been perfectly accurate, stated it to be 628. If this produce be eaten by hogs, or cows, or sheep (for all are equally fond of potatoes), I entertain no doubt whatever that it will afford twenty times as much animal food as the same extent of ground would have yielded in permanent pasture; and I am perfectly satisfied, upon the evidence of facts, which I have recently ascertained, that if the whole of the manure afforded by the crops of potatoes, above mentioned, be returned to the field, it will be capable of affording as good, and even a better, crop, in the present year, than it did in the last; and that as long a succession of at least equally good crops might be obtained as the cultivator might choose, and with benefit to the soil of the field."

*Planting Potatoes whole.*—Mr. Knight recommends that potatoes should be planted whole. Of four plants, containing two eyes each, four, the crowns containing perhaps five or six eyes each; four small whole potatoes, four large whole ones; the produce of the first four roots weighed 8 lbs; that of the second four, 11 lbs.; that of the third 15 lbs.; that of the fourth four, 16 lbs.

Of this valuable root 72·6 parts in 100 are water, 15 starch, 7 fibre, or gluten, and 5·4 albumen, and mucilage. Two flour and 1 potatoes make excellent bread. The starch is superior to wheaten starch. With some gum tragacanth it is commonly sold for arrow-root, and, perhaps, is its equal.

In 100 lbs. of potatoes, only 25 parts are solid, or nutritive, while the remaining 75 consist of liquid. It contains, also, a dark acid substance, and it is highly important to get rid of this, which may be accomplished by repeated washings, after the root is grated. The nutritive parts of the potato consist —1. of flour and starch; and 2. of fibre. These, when the potatoes are grated, can be separated by a common strainer. The flour, which will be accumulated at the bottom of the tub, must be repeatedly washed, to clear it of the acid substance with which it is impregnated.

It can be converted into a jelly, in the same manner as arrow-root. For that purpose, it must be moistened with cold water, then put into a bowl, and boiling water gradually poured on it, constantly stirring it with a spoon, for a few minutes, till the jelly is formed. It will be improved by a little salt, or a little sugar, before the boiling water is poured on it. A wholesome and nourishing food is thus produced, which, with the addition of a little milk, is extremely palatable.

The quantity of flour, or starch, in a potato differs considerably, according to the sort, and the season. It varies from a fourth to a seventh part of the total weight of the root. In regard to the fibrous part, it is a most valuable article of food, whether dried for horses, or boiled for cows and pigs.

Mr. Jefcoat, of Gateshead, has proved that 21 lbs. of wheaten flour, kneaded with 12 lbs. of the fibre of potatoes, will produce 38 lbs. 8 oz. of excellent bread. His mode of preparing the fibre is as follows:—After washing it in two waters, he places it for about an hour upon a sieve to drain; then he adds, without its being boiled, the usual quantity of yeast, and after it has stood for about an hour, he works in the 21 lbs. of wheaten flour. It requires very little addition of water, but rather longer time in heaving, preparatory to its being placed in the oven. A moderate quantity of this bread should be taken with a proportion of the potato-jelly and milk at each meal.

The bread thus prepared continues equally good for several days, so that there is no necessity for constantly renewing it. The potato flour will keep.

If the price of wheat is high, a wholesome bread may be made with the potato fibre, and either barley flour, or oatmeal. The addition of some potato flour to the bread, instead of consuming it as a jelly, would make it much more nourishing. The potato fibre is an excellent ingredient in a pudding. It may be made either plain, for common use, or with a variety of ingredients, for the more opulent. To make it plain, take two spoonsful of the fibre of the potato, after it has been strained through a hair-sieve, boil it for half an hour, or even less, with two English pints of milk, adding two ounces of butter. Keep stirring it while on the fire; and if it becomes too thick, add more milk. Put it in a dish before the fire, or in an oven. Those who can afford it, make the following mixture:—Beat five or six eggs, and some sugar and spice, and a glass of brandy or whiskey. Some add, to give it a flavour, two or three teaspoonsful of marmalade. Let the pudding be put in a dish, and, when rather cold, pour the above ingredients into it; mix them well, and then set the dish in an oven, or before the fire, till it has got a fine brown colour.—*Sinclair.*

Potato flour, boiled with milk, and a little sugar, forms one of the most palatable, wholesome, and cheap dishes, and cannot be too strongly recommended to families, who ought always to convert a portion of their potato crop into flour, to be used when fresh potatoes cannot be got.

The farina of potatoes will not answer instead of wheaten flour, as it is nothing but pure starch, whereas the principal ingredient of common flour is gluten, of which wheat contains a larger proportion than any other grain. In the twenty-third number of the *Repertory of Arts*, there is an account of a method of granulating potatoes, by first steaming, and afterwards peeling them; then placing them in a tin cylinder, pierced full of small holes, into which a piston is fitted, when, by pressing down the piston, you force the pulp of the potatoes through the holes in the side; the pulp, as it comes out, takes the form of vermicelli, but afterwards, by its own weight, separates into small pieces the size of grains of rice, which when dried are similar to rice, and of an agreeable smell and transparent appearance. The pulp thus prepared is to be ground to flour, which, by being mixed with common wheaten flour in equal proportions, makes excellent bread, being very light, and capable of being kept a long time. It may be also used as common rice, either whole, or ground to powder in a coffee-mill.

In a pound and a quarter of potatoes, grate through a common tin bread-grater, into a pan of water, and stir with a wooden spoon, and as soon as the pulpy matter has subsided, the discoloured water is poured off, and clean water added, and the mass again stirred up. When it has settled a second time, the water is poured off by a gentle inclination of the vessel, and the process repeated till the water passed off is colourless. Three washings are sufficient. The residue is turned out of the pan, and dried in the air, and it produces four ounces of very fine white flour, or one-fifth of the original weight of the potatoes. It may be used as a substitute for arrow-root, for years. A bread-grater is the only instrument necessary.

*Potato flour, and Arrow-root flour.*—Potato flour may be known from arrow-root flour, by rubbing a little of it between the finger and thumb, when it will be observed that the potato flour is softer to the *touch*, and more shining to the *sight*, than arrow-root.

*Size from Potatoes.*—Starch of potatoes, quite fresh, and washed only once, may be employed to make size; which, mixed with chalk, and diluted in a little water, forms a very beautiful and good white for ceilings. This size has no smell, and is more durable.

*Potato Spirits.*—The potatoes are boiled by means of a steaming apparatus, and, where the apparatus is good, will be in a sufficient state of preparation in the space of ten minutes. As soon as they are in a proper state, they must be bruised when at as high a degree of temperature as possible, and then thrown, for the purpose of fermentation, into a tub, or other vessel, containing, for every 1,000 lbs. of potatoes, $416\frac{2}{3}$ lbs. of cold water; the temperature of which, however, should not be below ($63\frac{1}{2}$°). The whole must then be covered up, and allowed to remain. There will be 750 lbs. of sediment, contained in the quantity of potatoes which has been mentioned; and this proportion, with the $416\frac{2}{3}$ lbs. of water, will be quite sufficient to produce a mass of which the consistency will be that of pap, or curdled milk, and the temperature from (140° to $144\frac{1}{2}$°). There are then taken $31\frac{1}{4}$ lbs. of the malt of barley, which is steeped in 250 lbs. of water, that has been previously heated to the height of 60° R. (167° of Fahr.), and the whole is allowed to remain until it shall have cooled to the temperature of $81\frac{1}{2}$° F. There are then added $22\frac{1}{2}$ lbs. of yeast, which is mixed by being actively stirred, and the whole is then well covered and allowed to remain.—When the mass of fermenting potatoes is cooled to the temperature of $117\frac{1}{2}$° F., the fermentation is stopped by adding $416\frac{2}{3}$ lbs. of cold water, and the whole is well stirred together.—This mass having fallen to the temperature of $88\frac{1}{4}$° F., the prepared malt, which has already begun to ferment, is added; the whole is again well stirred together, the vessel very lightly covered, and the fermentation allowed to proceed. This latter operation takes place very regularly, and terminates in from 48 to 60 hours. The fermented mass assumes a spiritous odour, and furnishes, on distillation, so abundant a quantity of spirit, that, for every 100 lbs. of potatoes, there are obtained 8 pints of proof spirit.

*Beer from Potatoes.*—To prepare 11 gallons of beer, 110 lbs. of potatoes must be boiled, either in water, or by steam. After being boiled, they are bruised, and thrown with 2 gallons of water into a cauldron, when they are reduced to the consistency of thick milk. While this operation is going forward, 6 lbs. of malt are allowed to steep in 1 gallon of tepid water. To this the liquid mixture of potatoes is added, at the temperature of (144°), and after being well shaken, the whole is carefully covered up, and allowed to remain for three or four hours. When this time is elapsed, the mixture is again put into the cauldron, where it is gradually reduced to the proper consistency by the addition of 2 lbs. of hops. It is then passed through a hop sieve, and left to cool. When it is cooled to the temperature of 59°, a quarter of a pound of liquid yeast is added. As soon as fermentation commences, the liquor is skimmed, and drawn off into a cask, where the fermenting process is allowed to finish.

The best way of cooking potatoes, is, to boil them three or four minutes, with a little salt in the water; then, to pour off the hot water, fill up the pot with cold water, and put into it a piece of unslaked lime, about the size of a moderate-sized walnut, to eight or ten lbs. of potatoes; when sufficiently cooked, pour off the water, and keep the pot three or four minutes over the fire, so as to dry them.—*Gill's Rep.*

Another method of cooking potatoes is to wash them, and lay them in an iron or tin pan, and cover this with another pan, close; then send them to an oven, and in half an hour they are deliciously done.

*To preserve Potatoes from frost.*—The only precaution necessary, is to keep the potatoes in a perfectly dark place for some days after the thaw has commenced. In America, where they are sometimes frozen as hard as stones, they rot if thawed in the light; but if thawed in darkness they lose very little of their natural odour and properties.

Potatoes, at the depth of one foot in the ground, produce shoots near the end of spring; at the depth of two feet they appear in the middle of summer; at three feet they are very short, and never come to the surface; and between three and five feet they cease to vegetate. Parcels of potatoes, buried in a garden at the depth of three and a half feet, were not removed till after one or two years, and they were then found without any shoots, and possessed their original freshness and flavour.

Frozen potatoes raised into day-light rot, but if kept in a dark place, while thawing, they are sweet and good.

Boiled potatoes greatly improve mortar.

POTTERY.—To improve BRITISH POTTERY, to the perfection of Nankin, it is necessary to oppose the erroneous principles at present prevalent, in the *mixing* of the components, and in the employment of certain materials.

The compound of the body is that which constitutes the good, or the bad pottery; and to the potter is indispensable the knowledge of the materials which will make permanent pottery; as, also, of those which must be altogether excluded from every process, whether as a component, or to grind either of those in the body, or glaze.

The rise of British pottery is readily traced to a few persons, who have introduced into the *body* and *glaze* one or more of the components.

| *Body.* | | *Glaze.* |
|---|---|---|
| Brick clay | Unknown | |
| Fire clay | Thomas Toft | Lead |
| Red marl | Ellers—Brothers | Arsenic |
| Flint | Thomas Anbury | Potash |
| Basaltes | Ralph Shaw | Carbonate } Soda |
| Barytes | Josiah Wedgwood | Muriate, and } Soda |
| | | Borate of } Soda |
| Granite | Cookworthy, and Champion | Boracic acid |
| Felspar | James Ryan | |

Mr. E. Wood, Burslem, has arranged specimens of the manufacture, in eras of fifty years, from 1600, to the present day. Here are most instructively exhibited, in the greatest variety of forms and designs, the results of manipulations and combinations of the different earths; and especially of the red and the fire clays, and the obvious changes in the art, even in the same processes.

The introduction of flint into the body, with an addition of pipe clay, had the effect of improving the whiteness of the ware; but an endless variety of evils are consequent on *over*, as well as *under flinting*.

Among the new materials introduced into the body and glaze is that aggregate substance Cornish granite, of which there would be much difficulty to find two tons wholly alike in quality, or similar in the proportions as well as species of its components. Its crystallized quartz, and also its felspar, are well adapted for the purposes of the manufacture; and, especially, when these are combined with the other components in definite proportions. But these are deteriorated by the mica inseparable from them; and which injures all ware into which it enters. For when the phosphoric acid of the mica is brought into action by sulphuretted hydrogen, the glaze becomes poor and defective, and the ware of no value.

The *crazing* of ware is a defect of the most injurious kind; and in the censures it causes, all manufacturers are implicated. It injures them, nationally, as placed in competition with Europe and China; it injures them locally, by giving the character of superiority to the productions of other places.

Let two milk-pans be used, equal in size; but one glazed with the semi-fusion of the silex and alumine in the surface of the pots, caused by the action of the soda, and intense heat of the muriatic acid, while being volatilized in the potters' oven; and the other glazed with lead, ascertained by being breathed on, and a sulphur match burned beneath. Let each hold the quantity of milk to produce butter worth *sixpence*. The salt glazed pan needs to be merely washed with cold water, and the rising of cream proceeds regularly on every occasion. But the lead glaze must be washed with boiling water, and this only takes off the outward mass, leaving the lead affected by the lactic acid, thus caused to operate. Lead, however, at 212°, expands 1-356th, and more at the heat required for baking the glaze; hence, its tendency to *craze*; or assume that peculiar appearance of crystallization in innumerable small clearages, never witnessed in the salt glazed vessel, nor in any other pottery whose body and glaze are compounded agreeably to the law of equivalents. The pores, or cleavages, become charged with strong lactic acid, not to be neutralized by any subsequent washing; and which is even more powerful, when it is combined with the acid brought into action from manganese. The milk left to supply cream in such vessels becomes partially acidulated, and so much more is the disappointment in quantity of cream.

All glazes should be so compounded as to differ from, if not wholly to preclude any possible regular order of crystallization. Thin glazes seldom or never erase. As sodium remains fixed at the heat which melts plate-glass, its oxide, SODA, is a valuable and useful component of glazes that are not liable to craze; for it causes the other components to flow more readily, while hot, without streak or bubble, and yet remain equally durable when cold. But this will intimate the useless employment of muriate of soda, to keep the lead from precipitating in the dipping-tub, where the contrary effect would ensue; even if injury were not consequent on the muriate being volatilized by the baking. TIN, at 212°, expands 1-414: but renders the glaze opaque. ARSENIC is occasionally employed, as, while being volatilized, it abstracts carbonaceous matter. BORAX alike facilitates the fusion of the other components, and prevents bubbles or specks. When there remain particles of iron in the body, the action of the borax causes a yellow discolouration.

*This subject is discussed more at large in previous articles.*

POULTRY.—In these animals, cold exercises a constant and determinate action on the lungs. The effect of this action is the more rapid and more severe the younger the animal is. When cold does not cause acute and speedily-fatal inflammation of the lungs, it produces a chronic inflammation, which is pulmonary consumption. Heat always prevents the attack, and, when it has taken place, suspends its progress, and even sometimes arrests it entirely, and effects a complete cure. Pulmonary consumption is never, in any stage, contagious; and fowls affected with that disease, are not only all day long with the healthy fowls, but at night roosted in the same places, without communicating their disease to them. Lastly, the action of too-long confined air exposes these animals to abscesses of the cornea, and inflammation of the ball of the eye; and these abscesses and inflammations are also caused by cold, especially with moisture.

*Breeding Poultry.*—The houses for this purpose may be built either of brick or stone, one story high, with wooden roofs, and must be heated by cast-iron steam-pipes. Their cielings and walls must be finished with Roman cement. Each house is to be divided into four compartments:—the first for hatching and rearing chickens; the second for breeding turkeys; the third for ducks; and the fourth for geese. A furnace is built at one end, with a steam-boiler to hold 50 gallons of water, which will heat a house 80 ft. in length. The first two compartments must have the steam-pipes pass around both rooms at the bottom of the walls, for hatching chicken and turkey eggs, and they must pass once around the other two rooms, ducks and geese requiring less heat. The boiler must be also so constructed as to steam potatoes, parsnips, carrots, and herbs: which, when cooked, and mixed with milk, barley, oats, or peas, meal, or flour, produce the finest chickens, and other poultry.

To make the hens lay all through the winter, mix powdered oyster-shells and slate, or decomposed schistus with their food. The lime in the oyster-shells is necessary to form the shells of the eggs, and the slate improves their quality and flavour.—*Gill's Repository.*

POUND.—The English avoirdupois ℔. is 7000 grs., and the troy ℔. 5760 grs., which last is 7021 old French grains, or 373 modern grammes.

In English grains, the Swiss ℔. is 8067·7. The Lombard 11784. The Ratisbon 8776·5. The Swedish 6563·1. The Polish 6271. The Venetian 7374·5. The Turkish cheki 4925·6. The Cologn mari 3641·2. The Vienna mari 4325. The French gramme 15·444. The decagramme, hecatogramme, kilogramme, and myriogramme, each 10 times more than the preceding, the last equal to 22 ℔s. 1 oz. 2 drs. English, or 154,440 grs.

POWER, is matter in motion, and, in our machines, is either the force of water falling towards the centre by the two-fold motions of the earth, or the concentration of moving gaseous atoms in animal lungs, or the concentration of the same atoms in fire, which, transferred to liquids, expands them into gases; a power which is appropriated variously in the steam-engine, &c. All power is transfer, or concentration, in the direction of previous power; and on the earth, and in the solar system, none is ever gained and lost. The mass of the earth moving 98065 feet per second, is the source of all the motions and powers on the earth, and in the atmosphere, deflected as it is by the rotation, and then returned to the centre, which alone suffers no deflection.

Power and motion are convertible terms, quantity being the same. To say that a body has power, is the same thing as to say that it has motion; or has motion, that it has power.

This arises from motion in one body being necessarily imparted to every body with which it comes into contact, by which it puts them into motion, and often separates masses into parts, which effects we call force or power. In this manner, power is distributed from body to body, and from atom to atom, and again from them to others, *ad infinitum.*

Local power is the motion of the mass

acquired by some transfer of other local motion or motions, of some other mass, as in collisions, or the concentration of the motion of atoms, as in the condensation or expansion of gases.

And all local motions of bodies are directly or indirectly deflections of the motions of larger masses, as of bodies on the earth, in regard to the motions of the earth, and of the earth itself in regard to the progressive motion of the whole solar system, and the reactious of the sun, in moving round the centre of the momentum of the system.

Our observations do not enable us to discover the more extended deflections which give motiou to the sun and its system; but analogy leads us to believe, that the same principle extends from atoms to planets, from planets to systems of planets, and from these to more universal combinations.

PRECIOUS STONES.—The celebrated sapphire and ruby mines, which have always afforded, and still continue to afford, the finest gems of this description in the world, are about five days' journey from Ava, Mo-gaot, and Kyatpyan. In these mines are found the following gems or stones:—the red sapphire, or oriental ruby; the oriental sapphire, the spinelle ruby, the white, the yellow, the green, the opalescent, the amethyst, and girasol sapphire, blue with a reddish reflection, with the common corundum or adamantine spar, in large quantities. The oriental ruby, perfect in regard to water, colour, and freedom from flaws, is scarce and high-priced even at Ava. The blue sapphire is more common. One specimen exhibited weighed nine hundred and fifty-one carats, but it was not perfect. The red sapphire has not this magnitude.

The *five* precious stones are garnet, hyacinth, sapphire, carnelian, and emerald.

Garnets are closely imitated by fusing 2 oz. of fine glass, 1 glass of antimony, 1 gr. of powder of cassius, and 1 gr. of manganese.

The base of all artificial stones is a compound of silex, potash, borax, red oxide of lead, and sometimes arsenic. Pure boracic acid and colourless quartz should be used in imitating them; and Hessian crucibles are preferred. The fusion should be continued in a potter's furnace for 24 hours. The more tranquil and continued it is, the denser the paste, and the greater its beauty.

PRECIPITATION, results when a body dissolved in a fluid is made to fall down in a concrete state. The most usual effect of precipitation is seen, when a compound substance being suspended in a solvent, another substance is added, which unites with one of the principles of the compound, aud separates the other, which, being insoluble in the fluid, falls down.

Precipitation, an important branch of analysis, is sometimes a union of the precipitant with one of the compound, by which the other falls; or, it is the formation of a compound, by which it falls. It embraces the whole science of chemistry, in the analysis of bodies. The following are a few cases:

Muriate of soda is a precipient of the oxides of silver and mercury.

Sulphuric acid is a precipient of barytes and boracic acid.

Muriatic acid precipitates the benzoic acid.

Muriate of bariates precipitates sulphuric acid and carbonic acid.

Muriate of lime precipitates oxalic acid, and this lime.

Tartaric acid and potash precipitates each other.

Lead is precipitated by sulphate of soda.

Copper is precipitated by iron.

Arsenic by nitrate of lead.

Alumina by ammonia.

Alcohol or soda precipitates sulphate of magnesia.

Cream is when an addition, instead of a precipitation, causes a rising to the top, or a scum.

In almost all cases, metals may be precipitated by alkaline salts, which, by the superior power of action on acids separate them from their solvents: but the difference of the alkalies produces different characters in the precipitates. With the pure fixed alkalies the oxides are commonly thrown down pure.

The acids frequently occasion precipitations from various causes. The alkalies saturated by acids, or neutral salts, sometimes disturb metallic solutions. Some metallic salts can decompose others, and precipitate their bases.

A solution of gold is precipitated by sulphate of iron; or, a solution of gold in aqua regia, is precipitated by a solution of tin in the same menstruum. The solution of tin must contain the metal as slightly oxided as possible. This is dropped into a solution of gold very much diluted.

The metals also precipitate one another after a certain order, and this order is found to be the same in all acid menstrua. Zinc prevails over iron; iron over lead; lead over tin; tin over copper; copper over silver; silver over mercury, &c.

Most of the precipitated metals possess the metallic aspect, and in this case they are always crystallized. But it sometimes happens that their affinity for oxygen is such, as to occasion them readily to absorb it, without any remarkable heat. Such are lead, bismuth, arsenic, and antimony; and, they combine with it, before the metal has arrived at the bottom of the vessel. A portion of the precipitant falls down in the state of oxide. In other cases, the two metallic oxides unite, and fall down in the most intimate state of union; such are those of copper and zinc, tin, and gold. Most of the precipitants become first black, then are bristled over with small ash-coloured needles, which speedily assume the metallic aspect.

The affinity of the metals to oxygen is in the following order; lead, bismuth, mercury, silver, arsenic, tin, antimony, nickel, zinc, manganese, iron, cobalt, copper, gold, and platina.

Charcoal decomposes the oxides of all metals: and, on the other hand, the oxides of zinc, iron, tin, and some others, have the property of decomposing carbonic acid. Phosphorus precipitates all the metals below lead. Sulphur reduces most metallic oxides; but many of them decompose sulphuric acid, when assisted by heat.

Almost all the metallic oxides may be thrown down, either completely or partially, by means of the alkalies, alkaline carbonates, or alkaline earths. Hydrosulphuret of potash, likewise, throws them almost all down.

These phenomena of precipitation are palpable cases of the action and reaction of acids and alkalies, and of degrees of the alkalinity of the metals, as deoxidized from their ores. Davy, who did not understand that all electricity was the separation and restoration of oxygen and nitrogen, or its modification hydrogen; instead of referring the phenomena to the primary cause—acid and alkali, referred it to their effect, electricity; and hence his electro-positive, and electro-negative theory, other words for acid and alkali, and not otherwise preferable, than as our acids and alkalies are not equally pure.

*Precipitate Ointment.*—In 2 oz. of solution of subcarbonate of soda dissolve 3 scr. of white precipitate, 2 drs. of flour of sulphur, and 1½ oz. of simple ointment.

*Red Precipitate Ointment.*—Red precipitate 1 oz., mix with 2 oz. of white wax, and 6 oz. of melted suet.

PREGNANCY, begins at the moment of conception, and ceases with that of birth. During pregnancy, the vital activity, especially of the womb, increases. The periodical discharge ceases, but the vessels of the womb become enlarged, more charged with blood, longer and straighter. Its cellular substance becomes softer, and more spongy, the sides thicker, the cavity wider. It loses the pear shape, and becomes more globular. It sinks during the first two months of pregnancy lower into the pelvis, but afterwards rises, and becomes larger; until, in the eighth month, the bottom of it can be felt externally in the region of the stomach. In the ninth month, it sinks again. In these changes the embryo developes itself, until it has reached, in the fortieth week, a sufficient degree of maturity to be able to live separate from the mother. But the vital activity is increased in the state of pregnancy, not only in the womb, but in the whole body, with healthy and vigorons women. They are rarely affected by contagious diseases; consumption is checked during pregnancy, but makes the more rapid progress after its completion. The stomach particularly suffers; hence, nausea, vomiting, a morbid loathing of, or craving for, particular dishes, which were till then indifferent.

The breasts become larger during pregnancy, and in which a milky substance collects, with a change of colour round the nipple. The advice of experienced female friends, during the whole period of pregnancy, is of course of the greatest value.

PRESCRIPTIONS.—Dr. Paris relates, that some prescriptions of Huxham contained 400 ingredients. The antidote of Mithridates contained 72. Such, however, is the precision of modern pharmacy that, in 179 prescriptions of Dr. P., not more than three or four contain six ingredients, and the average is only 3·5.

The same writer gives, in his Pharmacologia, a luminous analysis of the objects of medical combination. In one case, they add to each other's energy. In another, they increase the aptitude of the stomach; in some, they neutralize or separate, and, in others, guard the stomach; to produce varied results with one design, or varied results with different designs; the formation of new compounds in the stomach, the increase of solubility, or of chemical or mechanical action. Other objects are the improvement of aspect or flavour, or preservation from spontaneous decomposition.

PRESERVATION OF ANIMAL FLESH.—Animal substances are often preserved by *drying* in a stove, or oven, so as to evaporate the water. Cold or frost is used in northern countries, to preserve animal substances.

The skins of animals are preserved by tanning. They are immersed, for several days, or even weeks, in water with bark, mostly of oak or larch; and other astringent substances, as terra japonica, are employed, which shortens the time, but renders the substance more hard and brittle. Another method is by tawing. They are left to soak for six weeks in water with fresh slaked lime, changed twice, rinsed again, soaked in water mixed with wheat bran until they float, but when beaten down do not rise again; the bran is then scraped off. After a liquid paste is prepared,—for 100 sheep's skins in warm water, 8 lbs. of alum, and 3 lbs. of salt are dissolved, and added to 20 lbs. of fine wheat flour, and 96 yolks of eggs. A ladle full of this paste is put into a trough of warm water, in which 12 skins remain some time, and are then pulled and stretched; and this is repeated twice; they are then left six days, and afterwards dried quick.—*See* SKINS.

The brine of common salt is easy and effectual. A saturated solution of salt in water, is composed of about 28 oz. of dry salt, and 72 oz. of water, or it will require 4 lbs. of salt to each imperial gallon of water. The meat, or fish, is put into this brine, and covered with a board, loaded with a lump of salt, or with large grained salt, to keep the substances under the brine, and the brine at full strength, as weakened by the juices of the meat or fish. After remaining in the brine two or three days it is taken out, and dried by either rubbing with bran or pollard for present use, or packed in barrels with large grained salt for longer keeping, or hung up in a smoking room. When the brine is loaded with the juices, it must be boiled in an iron pot, carefully scummed, and strained through a canvas or flannel bag, adding water in boiling to dissolve most of the salt settled at the bottom. Never put different sorts of meat or fish into the same brine, although boiling and scumming the brine will keep it a long time. An oz. of saltpetre to each lb. of salt will preserve the red colour of the meat, and the same quantity of brown sugar will improve its flavour.

The preservation of animal substances in strong vinegar is seldom practised; but a mixture of equal quantities of common vinegar, small beer, and water, is used to pickle some fish, as salmon, for present use, and keeps them a few days.—*See* PYROLIGNEOUS ACID, &c.

PRESERVING VEGETABLES AND THEIR JUICES, is effected by putting the substances into strong glass bottles, corked with care, and closed with lime and soft cheese spread on rags, and wires over. The bottles are then to be put into the copper, which is to be gradually heated, till it boils, and the substances in the bottles are boiled in their own juices. The whole is then left to cool, and the bottles, on being taken out, are to be examined before they are stored away, lest any of them should have cracked, or lutes have broken.

To preserve fruit in water, take fruit or pulse, not quite ripe, and put it into wide-necked bottles, and place it in a copper, nearly up to their mouths, and lightly cork them. Heat the water till very hot, but not to scald, and keep it up for half an hour. Then take them out, and immediately fill them with boiling water to the very brim. Carefully cork and wire them, and place on their sides in the store, but turn them occasionally, to prevent mouldiness.

PRESERVING FRUITS.—Observe, in making syrups, that the sugar is well dissolved before it is placed on the fire, otherwise the scum will not rise well, nor the fruit obtain its best colour. When stone-fruits are preserved, cover them with mutton suet rendered, to exclude the air. All wet sweet-meats must be kept dry and cool, to preserve them from mouldiness and damp. Dip a piece of writing-paper in brandy, lay it close upon the sweetmeats, cover them tight with paper, and they will keep well for any length of time.

*To bottle Damsons.*—Put damsons, before they are too ripe, into wide-mouthed bottles, and cork them down tight; then put them into a moderately-heated oven, and about three hours will do them; observe that the oven is not too hot, otherwise it will make the fruit fly. All kinds of fruits that are bottled may be done in the same way, and they will keep two years. After they are done, they must be put away with the mouth downward, in a cool place, to keep them from fermenting.

*To preserve Barberries.*—Set an equal quantity of barberries and sugar in a kettle of boiling water, till the sugar is melted and the barberries quite soft; let them remain all night. Put them, next day, into a preserving-pan, and boil them 15 minutes; then put them into jars, tie them close, and set by for use.

*To dry Cherries.*—Having stoned the desired quantity of morello cherries, put $1\frac{1}{4}$ lb. of fine sugar to every lb.; beat and sift it over the cherries, and let them stand all night. Take them out of their sugar, and, to every lb. of sugar, put two spoonsful of water. Boil and skim it well, and then put in the cherries; boil the sugar over them, and next morning strain them, and, to every lb. of syrup, put $\frac{1}{2}$ lb. more sugar; boil it till it is a little thicker, then put in the cherries and let them boil gently. The next day strain them, put them in a stove, and turn them till dry.

*To preserve Fruits in Brandy or other spirits.*—Gather plums, apricots, cherries, peaches, and other juicy fruits, before they are perfectly ripe, and soak them, for some hours, in hard or alum water, to make them firm; as the moisture of the fruit weakens the spirit, it ought to be strong, therefore, add 5 oz. of sugar to each quart of spirit.

*To preserve Apricots.*—Infuse young apricots, before their stones become hard, into a pan of cold spring-water, with plenty of vine-leaves; set them over a slow fire, until they are quite yellow, then take them out and rub them with a flannel and salt, to take off the lint; put them into the pan to the same water and leaves, cover them close at a distance from the fire, until they are a fine light green, then pick out all the bad ones. Boil the best gently two or three times in a thin syrup, and let them be quite cold each time before you boil them. When they look plump and clear, make a syrup of double-refined sugar, but not too thick; give your apricots a gentle boil in it, and then put them into the pots or glasses, dip a paper in brandy, lay it over them, tie them close.

*To preserve Gooseberries.*—Put an oz. of roche alum, beat very fine, into a large pan of boiling hard water; place a few gooseberries at the bottom of a hair-sieve, and hold them in the water till they turn white. Then take out the sieve, and spread the gooseberries between two cloths; put more into the sieve, and repeat it till they are all done: put the water into a glazed pot until the next day, then put the gooseberries into wide-mouthed bottles; pick out all the cracked and broken ones, pour the water clear out of the pot, and fill the bottles with it, cork them loosely, and let them stand a fortnight. If they rise to the corks, draw them out, and let them stand two or three days uncorked, then cork them close again.

*Preserving Apples, &c.*—In autumn, when the apples are gathered, they are laid on square wicker hurdles, constructed for the purpose, and which fit into a frame, one above another, upon ledges, so that those above do not rest on the fruit below. The lowest tier of fruit must be high enough from the ground to permit a fire of brushwood to be kindled below. The frame may be made to hold six or eight hurdles, and when overspread with fruit, each placed separately, its sides are covered with mats, to keep the smoke closely and longer within. A fire is made of vine branches, and continued till the fruit are, as it were, glazed over with the fuliginous matter from the fire. The apples are then wrapped up singly in paper, and packed in chests or barrels.

*Nuts* are preserved through the winter by burying them in a pot, and covering with a slate or tile, with a weight.

*To preserve Pears.*—Winter pears should be packed in wooden boxes or casks, interlayered with clean sweet straw, closely shut down, and placed in a room out of the reach of frost. The fruit require examination every month, that those beginning to speck should be taken out.

*To preserve the common Blue Plum.*—When ripe, the fruit are gathered with great care (the hands being covered with soft gloves, and only the stalks touched, and laid one by one in the vessel till it is full. The vessels are then closely covered by wet bladders, so as to completely exclude the air, and buried or suspended in wells, or cellars, out of the reach of frost. In February or March they will be found excellent. The vessels should be small, as the fruit remains good but a very short time.

PRESS, Liberty of, the basis of all civil liberty, and the chief hope of truth on all subjects. It is, however, often abused to gratify personal malevolence, and corrupted by power and wealth to serve base purposes. It often becomes a monopoly, owing to the expence, and truth is then compromised, to secure large patronage. Against these abuses perfect freedom of the Press is the best guard. Personal calumny is another of its abuses, for which there is no suitable remedy but punishment, since the abuse endangers the enjoyment of the benefit, and the abuse of any benefit should always be punished in proportion to the value of the benefit.

PRESS, a well-known machine, used by book-binders, cloth-finishers, cotton-manufacturers, packers, &c. It usually consists of a fixed lower and upper plank, four or six inches thick, and a middle mobile plank, with a screw fixed to it, which works into the upper fixed plank. Or sometimes, as in cheese or cloathes presses, the screw, or screws, are fixed in the lower plank, passing through the upper one, which is made to press intervening bodies by nuts on its upper side. But, for heavy work, Bramah's hydraulic press is now preferred. A pint of water, giving a pressure of many tons, and without any personal exertion in the operator. By acting on the end of a lever, it is also used to tear up trees by their roots, and important in clearing new countries.

In the Transactions of the Royal Society of Nancy is described a very powerful hydrostatic press. It is composed of a large leather bag in the room of the large cylinder of common hydrostatic presses. This bag, 15 in. in diameter, is placed in a wooden cylinder, the sides of which are strengthened by iron bands. The bag, by expanding in this cylinder, presses upwards a wooden platform, on which are placed the materials to be compressed, and which are confined, as usual, between cross-beams, strongly jointed in a frame. A lad of 12 or 15 can, by this machine, exert a pressure of 70 to 80,000 lbs. The leather bag is rendered very tight and strong by means of copper rivets.

*Press for compressing Flour or Meal into Casks.*—Every barrel ought to be of the size to contain 196 English lbs. of meal or flour, when compressed. An empty barrel, with a false one of the same size (that is, one without the top and bottom), placed above it, are first put upon the scales. The tare is made; and the opposite end of the balance is charged with a weight of 196 lbs. Meal to that weight is then put into the two barrels standing in this position, as, in its uncompressed state, one barrel could not hold this quantity of meal. The barrels are then placed under the press, where a rammer, exactly fitting the barrel, is made to descend upon them; the shaft of the rammer mounts and descends between two muffling-boards, which serve to guide it. It is furnished with two small beams, which are fixed in a sort of pivot, and which form the extremity of a large lever. When this lever is lowered, it causes the rammer to descend upon the meal, and a sufficient degree of pressure is thus produced. But, should it be required to augment the power of the lever, this can be done by applying another lever to assist in working the large lever. When the pressure is finished the lever is raised, and the false barrel, which is now empty, is removed.

*Copper-plate, or Rolling-press, Printing.*—The rolling-press, which is employed in nearly every species of copper-plate printing, is divided into two parts, the body and the carriage. The body consists of two wooden cheeks, placed perpendicularly on a stand or foot, which sustains the whole press. From the foot, likewise, rise four other perpendicular pieces, joined by other cross or horizontal ones, which serve to sustain a smooth even plank or table, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, about six inches in diameter, borne up at each end by the cheeks, whose ends, which are lessened to about two inches diameter, and called trunnions, turn in the cheeks about two pieces of wood in form of half moons, lined with polished iron to facilitate their motion. Lastly, to one of the trunnions of the upper roller is fastened a cross, consisting of two levers, or pieces of wood, traversing each other, the arms of which cross serve instead of the bar or handle of the letter-press, by turning the upper roller, and, when the plank is between the two rollers, giving the same motion to the under one, by drawing the plank forward and backward. The ink usually employed is a composition made of the stones of peaches and apricots, the bones of sheep, and ivory all well burnt, and called *Frankfort Black*, mixed with nut-oil that has been well boiled; the two being ground together on a marble slab, in the same manner as painters grind their colours.

A small quantity of this ink is taken on a rubber, made of linen rags, strongly bound about each other, and then smeared over the whole face of the plate, as it lies on a grate over a charcoal fire. The plate being sufficiently inked, it is wiped over with a dirty rag, then with the palm of the left hand, then with that of the right; and to dry the hand, and forward the wiping, it is rubbed, from time to time, on whiting. In wiping the plate perfectly clean, but without taking the ink out of the engraving, consists the skill of the workman. The plate, thus prepared, is laid on the plank of the press, and over the plate is laid the paper, well moistened to receive the impression; and over the paper two or three folds of flannel. The arms of the cross are then pulled, and the plate, with its furniture, is passed through between the collars, which pinching very strongly, press the moistened paper into the strokes of the engraving, and it absorbs the ink from them.

*Type Printing-Press*, is the very important implement used for transferring the impressions of inked types to paper. The first printing was effected by a flat board with blows of a mallet. But the number of impressions rendered it necessary to convert the board into a solid platten, and carry this upon the paper, by means of a screw, and a lever to turn it. The types were inked with large balls, made of sheeps'-pelt, and the soft covering placed over the paper, to protect the types, and bring the paper into contact with the entire surface of each type; but, in time, this has been changed into the tympan-frame of parchment and interposed flannel. Such, with some changes and varieties in the parts, is the ordinary printing-press, which takes off from 150 to 300 impressions per hour. Lord Stanhope made an improvement in the lever, and the wooden platten was converted into an iron one; but the greatest improvement, of late years, was the patent rollers, for distributing the ink over the types. The paper is wetted, because the unctuous ink will then not run upon it, and it is thereby softened, so as to reach the entire surface of the types, when pressed through the flannels, &c. in the tympen.—*See* PRINTING MACHINE.

PRESSURE ON FLUIDS.—The air presses every where in right lines 15 lbs. to the square inch, as the result of the expansive power of all its atoms in right lines all round. Hence, if the lines are shorter on one side than another, the pressure is less on that side; so that, if we continue to diminish it to nothing, the pressure then acts as 15 lbs., just as we see in pumps, barometers, &c. &c. If we intercept the pressure on one side of a plate of glass, immersed in water, the interception on each side raises the water up the glass; if we double it by two plates of glass, the pressure being complete on the whole mass of the water, the water will rise, or will hang between the plates raised through the water, and the pressure, at the ends, will form it into an hyperbolic curve. But, if the pressure is intercepted all round, as by a tube, and the tube small, so that the pressure within the tube is the narrowed perpendicular pressure, while the whole pressure is on the water outside, the difference of force will be as the breadth and length of the tube; *i. e.* as the angle of downward pressure *exactly* to the whole angle of the 15 lbs. of pressure on the outside. From the very same cause nicely-poised bodies, or lightly-floating bodies, go together, or incline to each other by intercepting each others pressure, or shortening the line of pressure on one side. Hence, a poised plummet inclines to a mountain, poised lead balls to one another, floating-corks, boats, &c. But no floating body goes to another, if covered by the water, for then they lie as dead logs. In capillary tubes, the diameter and elevation are constantly equal multiples, as they ought to be on this theory. Mercury, being heavier than the tube, seeks to raise the tube, instead of rising itself, and by reaction sinks itself, by a converse action. In a tube the 20th of an inch, water usually rises about ·048 of an inch, vinegar the ·036, and sweet-oil ·024. In one the 25th, water 1 inch, milk ·8, oil ·6, vinegar ·95. It is one of the smallest topics of modern philosophy, but mystified by La Place, Ivory, and others, into a mighty problem.

PRESSURE MEASURE.—This is formed by taking a leaden bullet, 5-8ths of an inch diameter, as a *standard* of other pressures, by Mr. Bevan.

PRINTING, is the art of multiplying copies of books. It superceded the once-extensive business of copying. It was a mere extension of the art of coining and seal engraving, on which letters were reversed like types, but the impressions were taken in wax or metal. The first printing pages were blocks, like broad seals, cut in wood, and stampt on paper, which last was taught by card-making, cards being invented about half a century before, and the impressions made with ink and blocks. The first books were, therefore, in solid pages, like wood-cuts, and worked only on one side the paper, and a leaf was made by pasting the pages together. Soon after it was conceived that, as the same letters were so often repeated, the letters might be made separately, and then composed into a page. This was a great step, and the next was casting the types, instead of cutting each with the hand. The last, and, perhaps, the final improvements, have been the casting the types in solid pages, or stereotype, and the application of steam-power to machines for taking impressions. Looked at in the result, as cast-plates and printing-machines, the invention is wonderful; but, taken step by step, it is a lesson of modesty, and similar to all other inventions whose ultimate perfection never was contemplated by the successive improvers.

The art of printing has so multiplied books, that, in consequence, the book-trade has become a branch of commerce, and the importance of rendering the whole population intelligent has led to general instruction in the arts of reading and writing. Hence, books have become a necessary of civilized society, and the art of printing, which at first destroyed the copiers' trade, now employs a hundred times more than copying. There are, by the returns of 1831, no less than 8342 printers in the United Kingdom, above 21 years of age, and, probably, a third more under 21. Besides 3327 booksellers and 2797 called stationers, who also deal in books.

The art of printing also employs 157 type-founders and 3599 book-binders. And 4164 men above 21, half as many boys, and as many females, in all kinds of paper-making.

It likewise lays the basis of the engraver's art, in copper-plate and wood engraving, and is the source of extensive patronage to artists and designers, of which classes it constantly employs at least 1000 hands in the United Kingdom.

It serves, likewise, to give employment to authors and men of learning, some hundreds of whom subsist by writing for the press or in editing books. Unhappily, however, the expences of an edition render it a speculation of capital; and, as prejudices and predilections favour only standard or orthodox opinions, few authors or publishers adventure new or original opinions, the first object being a return of the capital sunk, and the second, a profit on the adventure. From this cause, printing has effected less for Truth than might have been expected; but it furnishes a superabundance of materials for thinking, to those who have sufficient intellectual vigour to think for themselves. Such a volume as the present, or the same Author's Million of Facts, will spread more knowledge in a year than the labours of 1000 copyists for 1000 years.

Compositors are paid by the number of square letters, or *ens*, in a page, reckoning the spaces, leads, &c. The price varies according to type, form, or trouble, and copy. On large types, in plain pages, it is from 4½*d*. to 5*d*. per 1000 ens, and it advances ½*d*. per 1000 up to 7*d*. and even 8*d*. per 1000, as the type is smaller and the composition more intricate, as tables, mathematics, foreign language, &c.

The pressman charges by the token, or 250 perfect, considered, in common work, as an hour's; but he varies for different types, or extra care, or as the number is increased, the adjustment, or making ready, for 250 being equal to that for 5000. A machine perfects 2000 or more, per hour, with the aid of only two boys; and hence, machine-printing is 50 or 60 per cent. cheaper than at the common press.

For the wear and tear of his types, presses, reading proofs, ink, gathering, &c. &c. the master-printer charges from 40 to 50 per cent. on the wages of his compositors and pressmen.

Germany employs twice as many persons in all these employments as the United Kingdom; France, and the United States, an equal number each; and the rest of Europe, collectively, the same as the United Kingdom. In all, at least 100,000 families subsist in the civilized world, by imparting knowledge or creating the facilities, besides the clergy and the instructors in schools, perhaps twice as many more.

PRINTING MACHINE, this is an adaptation of the printing-press to the moving power of steam. The types are laid on a stage, imposed in the usual manner, first one side of the sheet, and then, a little beyond it, the other side. They are inked by passing under rollers which are supplied with ink from above. The paper is then placed on a large roller by a boy, and the roller turning passes and presses the paper over the type, producing a perfect impression on one side. The sheet is then reversed by small rollers and carried to the next roller, which turns it over the other form of type and perfects it, when a boy removes it. During this time the first boy had laid another sheet on the first roller, the types had returned under the rollers, and received fresh ink from the ink rollers, the first roller had turned, the 2 small rollers had laid the reversed sheet on the second roller, which had turned and perfected it, and in the 9th or 12th of a second of time the last boy receives another sheet. The number perfected being from 2,000 to 3,000 per hour, or 20 times the number by ordinary press-work, performed by two hands and a boy. In consequence, the cost and charge is reduced one-half. A machine costs about £1,200.

PRINTING INK, is made of oil-varnish and fine lamp-black. The varnish is made by heating pure linseed-oil in a copper till it will light with a piece of lighted paper. It is then to burn away to three quarters, to two thirds, and one half for varnishes, of various consistence. The lamp-black is the soot of turpentine lamps, burnt in a close chamber, and the soot collected on flannels which line the room, and from time to time are beat out. In a large way the oil is not burnt, but evaporated, at nearly a boiling heat, to a thick consistence; and lamp-black is often made by burning pitch, &c. and collecting the soot in a horizontal chimney, which passes into a chamber hung with coarse cloths or flannel. The ink is made by gradually triturating the black with the varnish on a stone with a muller, but in the large way this is done by a horse-power with a wheel, in the manner of colour-grinding.

PRINTING ROLLERS.—An invention has been perfected, which to calico-printers has been a desideratum. It is a machine by which the most minute and delicate figures may be etched on a cylinder, superseding the tedious processes in use, and without the slightest deviation in the pattern, if there be even tens of thousands of objects to be engraved. Besides its other advantages, there is a considerable saving, both in labour and expense, as it may be worked by a boy.

PRINTING IN GOLD, is effected with a golden liquid, which runs like the ink commonly used. *Lead* has also been employed in the same manner as gold, so as to produce an appearance between that of a pencil-drawing and a wood-engraving.

-. Day has lately taken out a patent for improving the elastic action of lithographic and other presses.

*Calico-Printing.*—For the accurate junction of patterns in calicoes, &c. a patent has been taken out by Applegath. This apparatus is composed of two principal divisions, the first being of the nature of a table or stand, on which the calico, or other stuff required to be printed, is to be laid, and the second consisting of a frame that fulfils the chief purpose of the object of the patent. These slabs are placed successively in one line, within about an inch of each other, on parallel brick-walls, of between two and three feet in height, and over them is fixed a thick piece of blanket. A frame is then prepared to fix over this table, containing as many square compartments as there are slabs. One end of the piece to be printed is fixed, and it is then laid evenly over the slabs, and fastened down in the intervals between them. Supposing the calico or other stuff to be arranged and fastened down evenly over the table of slabs, and the frame to be let down horizontally, in contact with its surface, a block is then to be taken, having a fourth of the area of one of the square compartments of the frame, and the colour having been applied to its face, either by dipping it on the colour sieve, or by colour rollers, it is then to be pressed down by a blow or other means, in one corner of the first square compartment of the frame, then in the next corner, and so on successively. When a medallion or other central figure is to be impressed on the middle of the handkerchief or shawl, then a moveable frame is to be formed of four pieces of wood, of the length of one of the compartments, crossed so over each other (by dividing the joinings) as, when laid in the compartment, to divide its area into 9 equal squares; in the central square of these a block, having the whole of the intended medallion, or other figure, cut on its face, is then to be stamped; or a block, having a quarter of the same figure cut on it (and, of course, only a fourth of the area of the central square,) may be used, and the impression be made of the whole figure by four successive operations, in the same way as with the larger blocks. When only a border is to be stamped on a shawl or handkerchief, the patentee directs that a block be used, which is to be of the breadth of the intended border, and of such a length as to extend from one angle of the square compartment of the guiding frame to within a distance equal to its breadth, of the adjoining angle.

PRISM, a glass of three sides, which, by their obliquity, turn aside rays of light, and produce a coloured image. This may be viewed directly, or by a hole with a lens, and the distinct colours are *five*, red, yellow, green, blue, violet. The red is the oxygen or heating end, and the violet the de-oxidating end. The proportions are unequal, according to the angle and the substance of the prism. We are indebted to Dr. Thomas Young, and M. Malus, for a perfect analysis of the whole. It appears that light consists of undulations of the medium filling the space, something analogous to waves on water, and the breadth of the waves in red is the 37,000th of an inch, in yellow the 43,000th, in green the 47,000th.—. In blue the 53,000th, and in violet the 60,000th of an inch. Their interference and accumulation has been the subject of precise calculation, and made a means of measuring the size of very small bodies. Two stones thrown into water exactly illustrate the phenomena of interference, accumulation, &c.

Light beyond the violet ray blackens muriate of silver, reduces the nitro-muriatic solution of gold, when placed in contact with any vegetable or animal matter; and renders paler the red oxides of mercury and lead. The same rays render guaiacum green, and the other end changes it to yellow. It tends to decompose nitric acid by rendering it fuming. It aids crystallization, and it affects the colours of powders in closed bottles.

Biot obtained, by other prisms, a spectrum without the chemical end.

Berard, by the most accurate observations, determined that no heat extends beyond the red rays of the spectrum, and that all the heat of light is within the coloured parts of the spectrum.

In a prism properly adjusted only four colours appear, red, yellowish-green, blue, and violet. Newton, by taking too large a hole, made in 360°, red 45, orange 27, yellow 48, green 60, blue 60, indigo, 40, violet 80. If we consider the red as an oxygen effect, and the blue, indigo, and violet as nitrogen effects, we have 45 to 180, or 1 to 4 exactly. The orange, yellow, and green 135, seem to be middle tints, in which each 27, the orange, and 108 the yellow and blue, a consideration which seems to prove that light is a mere propulsion or vibration of the medium of the atmosphere.

The dispersive powers of prisms are water 0·035, flint-glass 0·052, carburet of sulphur 0·115, chromate of lead 0·4.

PROFILES, are rapidly drawn by a long rod, that turns on a joint. One end is passed over the face, and the other end traces the same lines on paper. Sometimes the shadow of a strong line on the wall is used, but the head requires to be fixed, and even breathing spoils the outline.

PRUSSIC OR HYDRO-CYANIC ACID, is generally procured by the distillation of the expressed cake of bitter almonds. The process is noxious to all concerned, and in its effluvium fatal to insects.

Prussic acid is the decomposition of Prussian blue, which consists of this acid and iron. It is made by adding red oxide of mercury to a solution of Prussian blue, in boiling water, till the blue colour is destroyed. Filter, concentrate, and cool. The crystals are Prussiate of mercury; and on them, in a retort, pour muriatic acid, and evaporate, with heat, through a tube filled one-third with pieces of marble and two-thirds with fused muriate of lime. The vapour, condensed in the tube, is prussic acid.

Strong heat, with light, converts it into carbonic acid, ammonia, and carburetted hydrogen. Its constituents are carbon 44, nitrogen 52, hydrogen 4, nearly.

Prussic acid is also obtained by exposing the horns, hoofs, and dried blood of animals, with fixed alkali to a red heat. United with iron it is prussian blue, and for experiments may be abstracted from that pigment. A dog's palate being touched with a glass rod dipped in it, the animal fell dead instantly, and such are its usual effects on animal life.

Prussic acid exists in the skin of the kernel of the seeds which produce it, as bitter almonds, the cherry-laurel, &c. &c. It is a compound of carbon and nitrogen, called cyanogen, with hydrogen, and hence called hydro-cyanic acid. It operates in medicine in very small doses, on the principle of allaying irritability without disturbing respiration.

The tests commonly employed for the detection of prussic acid, are, the smell, the taste, and the reaction of the suspected substance on the addition of certain saline solutions—viz. the solution of nitrate of silver, sulphate of copper, and of any salt of iron containing the black oxide of that metal. Of these tests the most delicate, but perhaps least certain, is the sense of smell: while the ferruginous solution, one of the most delicate, is, perhaps, the most certain of all.

PRUSSIAN BLUE, is made by mixing hydro-ferrocyanic acid or prussiate of potash with a solution of iron.

Prussian blue is the per-ferro-prussiate of iron, made by dissolving separately 1 ferro-prussiate of potash, 1 copperas, and 4 alum in water, and mixing them. The precipitate is prussian blue, which is dried on chalk in an oven.

PUDDINGSTONE (*breccias.*) Stones which consist of a siliceous ground or cement (commonly petrosilex, jasper, or siliceous grit) in which pebbles of silex or agate are interspersed; round or oval, they are called puddingstones, but if angular, breccias. Of the coarser sorts, mill-stones are often made.

PUMICE-STONE, a volcanic ejection or product.—The lighter sort is used for smoothing the surface of metals, wood, pasteboard, and stone.—Pumice-stone is likewise used as a glaze for pottery.

PURIFICATION.—For the several purifications, we are obliged to employ almost all the operations of chemistry. For instance, all the second distillations and sublimations are purifications, and employed for the purification of volatile substances from others that are fixed, or less volatile. Also the repeated solutions, filterations, evaporations, and crystallizations of neutral salts, are only means of purifying them. Several calcinations, and particularly those of fixed alkalies, are intended merely to purify them, by depriving them of a greasy matter or superabundant inflammable principle. Lastly, the repeated fusions of metallic substances, the smelting of ores, cupellations, and refining, are true purifications of metallic matters.

Purification of Gold, by antimony. The gold is to be melted in a crucible large enough to contain thrice the quantity of metal. When the gold is melted, twice its weight of sulphuret of antimony powdered is to be thrown upon it, the crucible is to be covered, and left some minutes in fusion; after which, when the mixture is well fused, and so hot that its surface sparkles, it is quickly to be poured into an iron cone, previously heated and greased. This matter consists, when cold, of two substances; the upper one of the sulphur of the antimony, united with the metals with which the gold was alloyed, and the lower is the gold united with a quantity of the antimony proportionable to the quantity of metals which have been separated from the gold, and which are now united with the sulphur of the antimony.

As a single fusion is not generally sufficient to disengage the gold from all its alloy, it ought to be fused again in the same manner, and with the same quantity of sulphuret of antimony.—When these first fusions have been well made, the gold obtained is alloyed with antimony only.

It is then to be put into a large crucible, and heated sufficiently to keep it in good fusion. With this heat the antimony will be dissipated into smoke, and the operation must be performed slowly, but may be abridged by blowing on the surface of the metallic mass, which greatly assists in the oxidation and evaporation of all bodies, and particularly of antimony. The purification is completed by means of a little nitric thrown into the crucible, which effectually oxides the remaining antimony. Sometimes the gold is deprived of its usual ductility, which is restored by fusing it with nitre and borax.

Purification of Silver, by nitre.—The silver is to be first granulated, and then mixed with a fourth part of its weight of dry nitre, an eighth part of potash, and a little common glass, all in powder. This mixture is to be put into a good crucible, two-thirds of which only must be full. This crucible is to be covered with a smaller crucible inverted, and luted to the former, and in the bottom of which a small hole has been made. The crucibles thus disposed are to be placed in a furnace, capable of drawing air sufficiently to make the fire intense enough only to melt the silver. Then charcoal is to be put into the furnace, to such a height that only the top of the inverted crucible shall be uncovered. The coal is then to be kindled, and the vessels to be made moderately red; a hot coal ought to be put upon the small hole in the bottom of the inverted crucible. If a shining light be observed round this coal, and a slight hissing noise be at the same time heard, the operation proceeds well. The fire must be sustained at the same degree till these appearances cease; when it must be increased so that the silver is well melted, and then the crucibles are to be taken out of the furnace. The larger crucible is to be broken when it is cold, and the silver will be found at the bottom, covered with a green alkaline scoria.

PULMONARY CONSUMPTION, or Phthisis, a disease, known by emaciation, debility, cough, hectic fever, and purulent expectoration. It begins with a short, dry cough, which at length becomes habitual, but from which nothing is spit up for some time, except a frothy mucus that seems to proceed from the fauces. The breathing is at the same time somewhat impeded, and upon the least bodily motion is much hurried; a sense of straitness, with oppression at the chest, is experienced: the body becomes gradually leaner, and great languor, with indolence, dejection of spirits, and loss of appetite prevail.

The diet, in this disorder, should be of a nutritious kind, but not heating, or difficult of digestion. Milk, especially that of the ass; farinaceous vegetables; acescent fruits; the different kinds of shell-fish; the lichen islandicus, boiled with milk, &c., are of this description. Some mode of excitement, regularly employed, particularly sailing; warm clothing, removal to a warm climate or to a pure and mild air, may materially concur in arresting the progress of the disease in its incipient stage. With regard to urgent symptoms, requiring palliation, the cough may be allayed by demulcents, but especially mild opiates, swallowed slowly; colliquative sweats by acids, particularly the mineral; diarrhœa by chalk and other astringents, but most effectually by small doses of opium.

PULSE.—The state of the pulse is an indication of the action of the heart and the whole arterial system. The circumstances are either the number of pulsations which take place in a given time, and the regularity or irregularity of their occurrence, or the character of each pulsation. The pulse is said to be quick or slow, according to the number of pulsations in a given interval, and regular or irregular as they occur at equal or unequal intervals. It is affected by the age, sex, and temperament of the individual, and by accidental circumstances, as sleep, food, exercise, heat, &c. The pulse is most rapid in childhood, making from 100 to 110 beats in a minute, and is regular, and rather soft and small. In youth it is much less rapid, making ninety beats a minute, and regular, strong, rather soft than hard, moderately full. In mature age the number of beats is about 75 per minute, and the pulse is regular, strong, or moderate, fluctuating between hard and soft, between full and small. In old age the number of beats sinks to sixty. The pulse is sometimes irregular, strong, but slow, hard, rather full than small. In the female sex it is more rapid, softer and smaller than in the male. In the *sanguine* temperament it is quicker, fuller, softer; in the choleric, slower, harder, stronger; in the phlegmatic, slower, weaker, softer, fuller; in the melancholic, slow, hard, and strong. A vegetable diet makes it slow, weak, full, soft; a meat diet, spices, spirituous liquors, make it quick and hard. In a pure, clear air, it is quick; in damp, impure air, slow and languid. Sudden agitation and violent passions make it rapid and irregular; joy makes it quick and strong; long-continued grief languid and soft. The pulse is, therefore, a highly important indication of the state of the system.

PUMPS, are a contrivance for raising fluids by atmospheric pressure. The most common pump is the ordinary sucking, or household pump. It consists of a hollow tube descending to a reservoir of water, and containing an air-tight piston, attached by its rod to a lever. Another stationary box is inserted in the tube below the moveable one, and both are furnished with valves, or clappers, opening upward. When the pump is full of water, every stroke of the handle raises the moveable box, together with the column of water above it. When the handle is lifted, the box is pushed further down into the water, while its valve opens to allow the water to pass through. The valve then shuts, and the second stroke of the pump raises another column of water to the spout. As the action of this pump depends upon the pressure of the atmosphere, water cannot be raised by it from a depth of more than thirty-four feet below the upper valve; and, in practice, a much shorter limit is assigned.

A constant stream in a pump is produced by a *forcer*, which is a second piston, solid and working with the other, so that the additional barrel communicates to the space between the two valves of the pump, and the flow is constant.

The lifting-pumps raise water but 32 feet by the atmospheric pressure of 34 ft.; but forcing-pumps will raise it to any height.

A 3-ft. stroke of a pump is called 2 ft. 9 inc. owing to waste in the valves.

Pumps have been contrived without a moving valve, by working, upward and downward, a leathern sack or bag in a piston, with a valve in its centre, by raising and depressing which bag with a rod and handle, water is raised in large quantities.

Whitehurst's pump is horizontal, and in the middle of its pipe is an enlarged air-vessel, into which the water rushes above its level, and then is elevated a short heighth by the condensed air. The hydraulic ram of Montgolfier produces an elevation of water, by the compression of a smaller bore to the tube as it lengthens.

Pumps on the principle of Hero's fountain are used for irrigating land, and one is employed at Chemnitz to raise water 136 feet. Brown's vacuum engine and steam-power now supercede all old machines for raising water. They are baubles compared with these powerful instruments, of which the great London water-works present such magnificent examples.—*See* ENGINES, &c.

PULPS. The pods of *cassia fistula* being broken, the pulp is washed out with cold water, strained, and evaporated to a pilular consistence.—*Tamarind Pulp* is prepared in like manner.

*Prune Pulp* is prepared in the same manner, but the prunes require boiling to soften them.

*Pulp of Elder Berries*, and of *Black Currants*, and the *Pulps of Dried Juices* of other sweet fruits may be prepared in a similar manner.

Brewer, by his patent-sieves, proposes to make them act by a crank with machine power, so as to shake the pulp into the vat.

PUTTY, used by glaziers, is fresh-kneaded chalk or whitening in fine powder with linseed-oil.

*Solvent for Putty.* Take American pearl-ash and mix it with slacked stone-burnt lime, to the consistency of paint, and apply the same. The greatest difficulty is to get it to enter the bedding putty, which must be done over with the solvent oftener. The same solvent will prevent the necessity of burning off paint; if applied with a brush over the whole surface, it soon destroys the tenacity.

PULVERIZING APPARATUS.—— Pounding is one of the most common methods of dividing solid substances into smaller particles. The chemist must, therefore, be provided with mortars of different kinds, glass, wood, iron-steel, marble, silicious stones, and porcelain ware, with their respective pestles. The nature of the substance which the chemist has occasion to pound must direct him in the choice of one mortar in preference to another. He must have glass mortars for rubbing together corrosive saline substances; while, for bruising succulent herbs, roots, and other recent vegetable substances, which do not require trituration, mortars made of box-wood, or oak, may be used.

PYRITES, are certain metallic combinations, which contain a very large proportion of sulphur. Pyrites generally contain less metal, and a larger quantity of mineralizing substances, sulphur and arsenic, and particularly of unmetallic earth, than ores. Almost every pyrites can strike sparks from steel, and from this property called fire-stone. They are formed in all earths and stones. Many of them are also found in coals, and in other bituminous matters.

Pyrites is also distinguishable from ores by its lustre and figure, which is almost always regular and uniform, and the regularity of its form by the quantity of mineralizing substances which it contains. When we see a mineral that is heavy, possessed of metallic lustre, and of any regular form, the mass of which is entire, so hard as to be capable of striking sparks from steel, such mineral is a pyrites, and not an ore. They are spherical, oval, cylindrical, pyramidal, prismatical, cubic; they are solids with 5, 6, 7, 8, 9, 10, and more sides. Some of them are called sulphureous, martial, cupreous, arsenical, as one or other of these substances predominates. In general, all pyrites are martial, as ferruginous earth is the essential and fundamental part. This earth is united with an *unmetallic* earth, with sulphur or arsenic.

The *white* pyrites contain most arsenic, and are similar to cobalt and other minerals abounding in arsenic.—*Yellowish* pyrites is chiefly composed of sulphur and iron.—*Yellow* pyrites receives its colour from the copper and sulphur which enter into its composition.—Arsenic is the cause of whiteness in pyrites, and is contained in every pyrites of that colour; and copper is the principal cause of the yellow colour of pyrites. It also contains a considerable quantity of *unmetallic earth*, that is, an earth which cannot by any process be reduced to metal. Henckel thinks, that it is an earth *disposed already by* *nature* to *metallization*, but not sufficiently elaborated to be a metal.

This unmetallic earth, so often quoted by chemists, seems to point to an intermediate state between earth and metal, on which the galvanic action which finally produces metals has not perfected its degree of change. On these subjects, we are on the eve of great discoveries.

PYROMETER; an instrument for the measurement of temperatures above those which we are able to estimate by the mercurial thermometer.

That of Daniel has superceded that of Wedgewood. It consists of a bar of platina, and a tube of black lead. Its determinations are made by an index, attached to the platina bar, which expands and contracts, and the index traverses a circular scale fixed to the tube, and is invariable when applied to the same objects. Wedgewood's gives the same indications at a low heat long continued, as to great heat suddenly brought in contact, and therefore fails.

Guyton de Morveau presented to the French Institute a pyrometer of platina, which measured high temperatures by the expansion of this refractory metal. An improvement of this instrument was brought forward by Mr. Daniel in 1821, which consisted of a bar of platina ten one-fifth inches long, and 0·14 inch in diameter. It is placed in a tube of black lead or earthen ware, and the difference between the expansion of the platina bar and the earthen ware tube is indicated on a circular scale. This pyrometer indicates a change of about 7° of Fahrenheit; or, in other words, 1° of Daniel is equal to 7° of Fahrenheit.—The following are some of the results obtained by this instrument:

| | Daniel. | Fahr. |
|---|---|---|
| Boiling point of mercury, | 92° | 644° |
| Fusing point of tin, | 63 | 441 |
| " " bismuth, | 66 | 462 |
| " " lead, | 87 | 609 |
| " " zinc, | 94 | 648 |
| " " brass, | 267 | 1869 |
| " " silver, | 319 | 2233 |
| Fusing point of copper, | 364 | 2548 |
| " " gold, | 370 | 2590 |
| " " cast-iron, | 497 | 3479 |
| Red heat just visible in day-light, - | 140 | 980 |
| Heat of a common fire, | 163 | 1141 |

*Fusing Points of Metals, derived from their Expansions to 212° and 662°, supposed equable.*

| | From 212° rate. | From 662° rate. | Real Temperature. |
|---|---|---|---|
| Tin | 471° | .... | 442° by Thermometer. |
| Lead | 670 | .... | 612 by Thermometer. |
| Zinc | 848 | 960 ? | 773 by Pyrometer. |
| Silver | 2159 | 2049 | 1873 by Pyrometer. |
| Copper | 3262 | 2366 | 1996 by Pyrometer. |
| Cast-iron | 3096 | 2489 | 2786 by Pyrometer. |

PYROPHORUS; an artificial product, which takes fire on exposure to the air. It is prepared by several methods. Four or five parts of burnt alum are mingled with two of charcoal powder. The mixture is introduced into a vial or matrass, with a neck of about six inches long. The vial is filled about two-thirds full, and put into a crucible, the bottom of which is covered with sand. The body of the flask is also surrounded with sand, after which the crucible is put into a furnace, and surrounded with red-hot coals. The fire is gradually increased until the flask becomes red-hot, at which temperature it is maintained for about a quarter of an hour. As soon as the vessel is become cool enough to be handled, the vial is taken out of the sand, and the contents transferred into a dry and stout glass, made warm, which must be secured with a glass stopper. Whenever this mixture is poured out in the air, it takes fire.

A pyrophorus may be prepared by mixing three parts of alum with one of wheat flour, and calcining them in a vial, as in the above case.

Tartrate of lead, also, on being heated in a glass tube until it becomes converted into coaly matter, gives rise to a beautiful pyrophorus.

The pyrophorus, invented by Doctor Hare, is formed from heating a mixture of three parts lamp-black, four calcined alum and eight pearlashes, in a gun-barrel. The mixture is maintained at a cherry-red heat about one hour, or until it ceases to give off inflammable gas at the orifice of the tube, after which it is withdrawn from the furnace, and closely corked from the air. When cold, if poured from the gun-barrel into the air, it immediately glows and takes fire: and more especially if breathed upon, or slightly moistened. This pyrophorus may be preserved in its full activity for a year or more, if well corked up from the air, but it requires much caution in disengaging it from the tube; for it has been known to explode, with great violence, simply on introducing into it an iron ramrod.

The ingredients are, 1. saltpetre, purified for the purpose; 2. sulphur; and, 3. charcoal. Gunpowder is used when ground or *mealed*. Camphor and gum-benzoin are ingredients in odoriferous fire-works. When stars are wanted, camphor, alcohol, antimony, and other ingredients, are required, according as the stars are to be blue, white, &c. In some cases, gold and silver rain is required; then brass-dust, steel-dust, saw-dust, &c., enter into the composition. Hence the varieties may be almost indefinite. With respect to colour, sulphur gives a blue, camphor a white or pale color, saltpetre a clear white yellow, sal-ammoniac a green, antimony a reddish, rosin a copper colour.

PYROTECHNICS, is the art of making fireworks. In this art, the chief objects are to produce a stream of fire, or an explosion.

A sky-rocket is formed by ramming a composition into a paper tube, to which an arrow or tail is connected. The explosive stream gives the rocket a progressive motion by its reaction. It is usual to include gunpowder in the head of the rocket, with balls of a still more slowly-burning compound, with additions to vary the colour they exhibit at the instant of the explosion, and for a few seconds afterward.

For making rockets, meal-powder only is commonly employed, and mixed with an additional quantity of sulphur and nitre, according to the different purposes for which they are designed; on which account the last ingredient is generally brought into the form of a powder, by solution and evaporation, during which latter operation it is continually stirred.

For fuses, 7 parts of meal-powder, 5 of nitre, and 3 of sulphur; and for rockets, 36 parts of nitre, 8 of sulphur, and 14 of charcoal, are to be taken; in both these the intention is, that the powder shall only be fired by degrees.

For blue-balls, are to be mixed together 13 parts of nitre, 3 of sulphur, 17-32 parts of resin, 7-16 of saw-dust, and 9-16 of charcoal.

Light-balls require, for the dry sort, 2 parts of nitre, $\frac{1}{4}$ a part of sulphur, 3-16 of resin, $\frac{2}{3}$ of saw-dust, and $\frac{1}{2}$ a part of meal-powder; for the fusible, 8 parts of sulphur, 2 of nitre, and 4 of meal-powder.

Fire-balls are composed of 20 parts of corned powder, 10 of pitch, 6 of nitre, 4 of sulphur, 1 of tallow, 1 of hemp, and 2 of linseed-oil.

Water-rockets require 8 parts of meal-powder, 36 of nitre, 7 of sulphur, and 1 of resin.

The variously-coloured fire-works depend on various additions, by which the natural colour of gunpowder, when on fire, may be altered, and in which metallic substances, for the most part such as antimony, zinc, marcasite, verdigris, &c. are employed. Thus, clean filings of iron produce what is called brilliant, or white fire.

But, as an art more amusing than useful, and whose manipulations are only learned by experience, fuller notice would be misplaced in this work.

PYROXYLIC SPIRIT, is a name for pyrolineous acid. It is 6 hydrogen, 5 carbon, and 4 oxygen.—*See* ACID, VINEGAR, &c.

QUACK MEDICINES, are preparations, coloured and disguised, of powerful drugs, which may, in general, be bought at respectable chemists at 1-10th of their price thus prepared. They are speculations of adventurers, to take advantage of public gullibility, by specious advertisements and extravagant assumptions. The useful multiplication of regular chemists' shops has, however, greatly tended to destroy these speculations.

QUARRYING, is the extracting stones from strata lying in regular layers, and performed by the pick, wedge, lever, or iron crow, and hammer. When not in layers, or in rocks, harder than sandstone, recourse is had to blasting, for which Hancock's fuses are a very successful modern invention.

QUARTETTO; a musical composition for four instruments, generally stringed instruments, in concert (*i. e.* two violins, one viol, and one violincello;) also a composition for four voices, with accompaniment.

QUARTZ, a mineral species, which surpasses all others in the *extent* of its distribution, and numerous as respects colour, lustre, and fracture.

The crystals of quartz are, for the most part, regular six-sided prisms, terminated at one, or both, of their extremities by six-sided pyramids, the faces of which correspond to the sides of the prism, and meet under an angle of 141° 40′.

It sometimes happens that the prism intervening between the two pyramids is very short, or even extinct; in which case the form becomes the dodecahedron, with isosceles triangular faces.

In the six-sided prism with pyramidal terminations, we often observe the solid angles, situated between the prism and the pyramid, replaced by rhomboidal planes. The alternate faces of the prism are striated horizontally. The primary form is a rhomboid of 94° 15′ and 85° 45′, parallel to whose planes cleavages may be obtained, as also to the planes of the dodecahedron, with isosceles triangular faces.

The principal varieties of quartz, which are known by distinct names, are the following:—

*Rock crystal* is applied to the transparent and colourless crystals, and more particularly to those of a large size.

*Smoky quartz* consists of those crystals, and crystalline masses, which are translucent and of a brown colour.

*Yellow quartz*, sometimes called, also, *Bohemian* or *Scottish topaz*, is transparent, and of various shades of yellow.

*Amethyst*, also in crystals, and for the most part nearly transparent, is of every shade of violet.

*Siderite*, or blue quartz, is never in regular crystals, but usually compact, and of an azure-blue colour.

*Rose quartz* is confined to translucent massive varieties, of a delicate rose-red colour.

*Milky quartz* is also massive, having an uneven fracture, is translucent, and of a milk-white colour.

*Irised quartz* embraces such crystallized varieties as exhibit in patches, at or beneath the surface, the colours of the rainbow.

*Common quartz* differs from milky quartz simply in being destitute of the milky whiteness of that variety, or in having an inferior degree of whiteness, and more of a vitreous lustre.

*Fat, or greasy quartz*, differs from common quartz merely in lustre, which, instead of being vitreous, has the appearance of being immersed in oil.

*Flint* has a more compact texture than common quartz, is dull, only translucent on the edges, of a brownish colour, and breaks conchoidal.

*Hornstone* closely resembles flint, from which it can scarcely be distinguished, except in its conchoidal fracture, which is much less distinct.

*Lydian stone*, sometimes called *flinty slate*, differs from flint chiefly in having a darker colour, less translucency, and a fracture somewhat slaty; when black it is often called *bassanite*.

*Floatstone* consists of a delicate tissue of minute crystals, visible only under a powerful magnifier. Owing to the cavities it contains, it sometimes will float on water.

*Fibrous quartz* consists of those varieties which are in distinct, parallel concretions.

*Radiating quartz* is like fibrous quartz, except that the fibres diverge from a common centre, and resemble radii, instead of being parallel.

*Chalcedony* includes those varieties of radiating quartz, where the thickness of the individuals becomes so much diminished as to render them nearly, or altogether impalpable; its masses generally offer a mammillary, or stalactitical surface, and the lustre on freshly-broken surfaces is feeble.

*Carnelian* differs from chalcedony merely in having a blood-red colour.

*Chrysoprase* also resembles chalcedony in composition, excepting that the individuals of which it is made up appear to be grains instead of fibres; its colour is apple-green, from the oxide of nickel.

*Agate* implies the occurrence of two, or more, of the above varieties, existing together in intimate union; or, it may be applied to a single variety, provided it offers different colours in the same specimens.

*Cats' eye* consists of transparent quartz traversed by exceedingly delicate parallel fibres of asbestus.

*Avanturine* is quartz penetrated by small golden-coloured spangles of mica.

*Prase* is quartz penetrated by green fibres of hornblende, which are often so small as to escape detection by the naked eye, and their presence is only discoverable from the green colour.

*Plasma* is a variety of chalcedony, coloured leek-green.

*Heliotrope* is likewise a variety of chalcedony, but coloured by a green earth, and occasionally dotted with minute portions of red jasper.

*Iron flint* consists of quartz, intermingled throughout with oxide of iron.

*Compostella hyacinth* is a red variety of iron flint, in regular six-sided prisms, with pyramidal extremities, which occurs imbedded in gypsum.

*Jasper* differs from the two last varieties in being massive, and in containing variable proportions of clay. Red and brown jasper simply allude to the colour of the compound. Striped jasper appears to contain a larger portion of clay, and is distinguished on account of its striped delineations.

*Jasper agate* consists of those varieties of jasper in which several colours are so arranged as to produce an agreeable effect.

*Mocha stone* consists of agate, containing appearances of vegetable filaments, which have been occasioned through the infiltration of iron and manganese through its crevices.

*Venus-hair agate* consists of quartz traversed by delicate hair-shaped crystals of any kind.

The most transparent varieties of quartz are pure silex, which, according to Berzelius, contains 49·70 silicon and 50·30 oxygen.

Quartz is infusible before the blowpipe, and shows itself to be pure silex. It is dissolved by soda easily, and with effervescence. Two pieces rubbed together emit an empyreumatic odour, and a phosphorescent light. Crystals of quartz may be obtained from a solution of silica in fluoric acid, or in potash diluted with water. Common quartz enters into the regular mixture of various rocks of granite, gneiss, mica slate, topaz rock, &c. In others, it occurs in single crystals, and in grains, as in porphyry. It also exists in beds by itself, as in quartz-rock, and some varieties of sandstone. Striped jasper and flinty slate form, also, particular beds. The varieties, prase and chalcedony, as well as amethyst, are often found in beds of iron ore. River sand, and that of extensive plains, where it is sometimes so fine as to drift before the wind, are formed chiefly of quartz. Common quartz, and several other varieties, are spread all over the earth, but certain varieties are confined to a few localities.

QUASSIA, *(quassia simaruba)* is a tree of moderate size, inhabiting various parts of tropical America, in a sandy soil. The bark, both of the trunk and roots, is of a pale yellow colour, and gives out a yellowish, milky, and bitter juice. It is the purest bitter known, and has long been employed by the inhabitants of Guiana. It is, in commerce, in the form of long, rolled strips. Quassia has no sensible odour. Its taste is that of a pure bitter, more intense and durable than that of almost any other known substance. It is used, in brewing malt-liquors, for hops.

QUERCITRON, the bark of a kind of oak, called yellow oak in New England, It is substituted for weld in the printing of linens; but only simply infused in warm water. To dye wool yellow, a solution of tin and alum should be put into the bath with the quercitron. Silk ought to be treated in the same manner as with weld, and if a very bright yellow be required, it must be prepared with solution of tin. Manufacturers of printed linens prefer this bark to weld, because it is considerably cheaper, and the ground whitens more easily. Some find it advantageous to mix a certain proportion of decoction of weld with the quercitron bath.

QUININE, or sulphate of quinia. This valuable concentration of bark, of which from 1 to 10 grs. is a dose, either in pills, or in weak dilute acid, is made as follows. Mix 1 lb. of pounded cinchonia cordifolio, or yellow bark, with a quart of pure water, and ½ an oz. of dilute sulphuric acid. Digest them at 212° for four hours, and strain the decoction. Mix and treat the residue, a second and third time, in like manner. Unite the whole, and add as much quicklime as will neutralize the acid. Filter the precipitate with paper, and add three pints of alcohol. Digest these with agitation for six hours, and then filter them. Add other three pints of alcohol to the residue, and again filter. Repeat the same. Then mix these tinctures and evaporate them to dryness in a vapour bath. Add to this residuum dilute sulphuric acid, creating an excess of acid. Then crystallize by evaporation and cold. The crystals are small, white, and silky, very bitter, and soluble in alcohol, or dilute sulphuric acid. The powder is sold in the shops, at 1*d*. per grain, 1*s*. per scr., or 15*s*. per oz.

Only 40 oz. of this substance, when in combination with sulphuric acid, can be extracted from 100 lbs. of the bark. In this instance, then, with every ton of useful matter, thirty-nine tons of rubbish are transported across the Atlantic. At the present time, the greatest part of the sulphate of quinia used in this country is imported from France, where the low price of the alcohol, by which it is extracted from the bark, renders the process cheap.

Quinine wine is made from the sulphate, by infusing 8 or 9 grs. in a bottle of sherry. Tincture, by dissolving 5 grs. in half a pint of rectified spirit. Red bark produces the most, but grey and yellow are also used, and other barks; and even casparia-root and capsicum-berries yield quinine.

QUINCE MARMALADE.—By boiling, evaporate 12 lbs. of quince-juice to half the weight, then add five lbs. of white wine, simmer away about four pints; cool, strain, add three lbs. of white sugar, and boil till it will be solid when cold.

RADCLIFF'S PURGING ELIXIR.—In two pints of alcohol infuse, for three weeks, 6 drs. of jalap, 5 of aloes, 2 of gentian, 1 of orange-peel, 1½ of cloves, and 2 scrs. of grains of paradise; then strain, and add 1½ drs. of each of senna-leaves in powder, jalap, and scammony.

RAGOUT SPICE.—Mix together ½ lb. each of flour of mustard, black-pepper, lemon-peel, 1 lb. of salt, 2 oz. of Cayenne pepper, and ¼ oz. each of allspice, ginger, and nutmeg; grind into a fine powder.

RAIL-ROADS.—The first railways, formed to make a distinct surface and track for wheels, seem to have been constructed near Newcastle, before 1676. The coals were conveyed from the mines to the banks of the river, by laying rails of timber exactly straight and parallel; and bulky carts were made with four rollers, fitting those rails, whereby the carriage was made so easy that one horse would draw four or five chaldrons of coal. About 1776, Mr. Curr constructed an iron rail-road, at the Sheffield colliery. The rails were supported by wooden sleepers, to which they were nailed. Twenty-five years afterwards, this species of road was successfully adopted on a public thoroughfare for the transportation of merchandise and passengers, at Stockton and Darlington.

There are 3 kinds of rail-roads, the *edge*, the *tram*, and the *suspension*, and each have some varieties. The oldest and most extensive plan consisted in laying rails of wood or iron, the carriages being guided thereon by flangs on the peripheries of the wheels, and these were called *edge-rails*, to distinguish them from *tram-plates*, which came into use afterwards.

The first was made of wood, near Newcastle, for conveying coals to the wharfs of the Tyne; and these were covered with plates of wrought-iron in the parts most liable to wear. Cast-iron was subsequently introduced there, as well as in many other parts of the country, and wrought-iron is now very generally substituted for cast-iron.

The waggons run upon the rounded edge of the rail, which is smooth, and laid as evenly as possible. The length of each rail is usually three feet, with a depth of four inches and a-half in the middle, and the breadth of the top is two inches. The ends of the rails rest on a block of cast-iron called a *chair*, and the chairs are fixed to blocks of stone, called *sleepers*, which have a broad base, and weigh about 2 cwt. They are firmly bedded in the ground, and are adjusted to the plane required for the road, before the chairs are connected with them, and the goodness of the road depends on fixing the sleepers sound and firm.

Rails made entirely of malleable iron were first employed at the collieries near Edinburgh; and were formed of rectangular bars, which presented too small a surface for the wheels, or otherwise require more materials than it would be consistent with economy to employ. To obviate this difficulty, a patent was obtained by Birkinshaw, of Bedlington, for an improved form, which consists in giving the bar the form of a triangular prism. The chief advantage of wrought-iron rails is the reduction of the number of joints; and the difficulty of making cast-iron rails perfectly even at the joints.

Edge-rails are best adapted for permanent works, and they are of such a nature that ordinary carriages cannot be employed upon them; but, on any railway where such carriages can be used, they must do more injury to the surfaces of the rails than will be equivalent to the advantage of suffering them to travel on them.

Tram-ways differ from the preceding in having the guiding flanch upon the rails, instead of being fixed upon the wheels of the carriages. It affords the advantage of employing such carriages as can be used where there are no rails. The tram-rail is exceedingly convenient for temporary uses, and, in its ordinary form, it is much used in quarries, in mines, in forming new roads, in digging canals, and in conveying large stones for buildings, and other purposes. Tram-rails are very weak, considering the quantity of iron in them, and in some works it has been found necessary to strengthen them, by adding a rib on the under side.

The third kind of railways mentioned are those on the principle of *suspension*, of which, that invented by Mr. Palmer is the earliest and the best. But Mr. Dick, of Ayrshire, has exhibited, in a room at Charing Cross, the model of a new railway, on the principle of suspension; that is, a railway supported by piers, raised at different intervals, and along which suspended carriages are to travel, wheels uppermost.

For permanent rail-roads, the rails are usually fixed by spikes, driven into wooden plugs, previously inserted in blocks of stone, or sleepers, for supporting the rails.

Le Caan's method affords facility in taking up or putting down the rails, being contrived so as to fix one another, without nailing. The plates are joined by a dovetailed notch and tenon, and an oblique plug is cast on each plate, which is let into the stone-sleeper. But, for the advantage of taking up the plates, to repair any defect, there are plates at every thirty yards, with perpendicular plugs, called stop-plates. The diameter of the plug near the shoulder is one inch and three-quarters, at the point one inch; its length is two inches and a half, and its obliquity about eight degrees. A small groove, in the whole length of the exterior of such plug, is made to allow the water in the hole to expand in freezing, and it also serves to admit a wire to draw a plug out by. The holes for the plugs should be cut to the depth of three inches, by a standard gauge of cast-iron, and counter sunk, so as to allow the end of the plate to bed firmly on the block which supports it.

The usual length of a one-tram plate is three feet; the flanch is one and a half inch high; the sole, or bed, three and a half or four inches broad, and three-fourths of an inch thick; but these dimensions are varied, according to circumstances: the most-approved weight has been 42 lbs. for each plate. The ends from which the plugs project, under which the tenons and notches are made, should be a quarter of an inch thicker than the other parts of the plate. By this method, the wheels of waggons cannot be obstructed by the heads of the nails rising above the surface, and the blocks are not disturbed by fixing the plates.

Turn-outs are made by means of a moveable or switch-rail, at the angle where the turn-out track branches from the main one. This rail is two or three feet, more or less, in length, and one end may be moved over that angle, and laid so as to form a part of the main track, or the turn-out track. The switch-rail is usually moved by the hand, so as to form a part of that track on which the waggon is to move.

The principal consideration, in regard to the carriages, relates to their bearings on the axle and the rim of the wheel. The rule given by Wood, as to the bearing on the axle, is, that, in order to produce the least friction, the breadth of the bearing should be equal to the diameter of the axle at the place of bearing. This diameter must be determined by the weight to be carried; and the breadth of the bearing will accordingly vary with it. The objection to the plate-rail is, that the breadth of the bearing of the rim of the wheel upon such a rail causes an unnecessarily additional friction; and the resistance to the wheel is increased in consequence of the greater liabity of such a rail to collect dust and other impediments upon its surface. The edge-rail is preferable, in these respects; but, at first, these rails were liable to one difficulty, in consequence of their wearing grooves in the rim of the wheel, so that the friction is continually increasing, and the wheel soon becomes unfit for use. To remedy this defect, the rims are case-hardened, or chilled, by rolling them, when hot, against a cold iron cylinder. Wheels so case-hardened are found to be subject to very little wear.

It has been found, in practice, that, for the ordinary inclinations of rail-roads, 30 feet per mile, the wheels may be so constructed as to move a train of waggons by their mere adhesion to the rails. The inclination which can be so overcome must evidently depend on the kind of surfaces of the rim of the wheel and the rail, the weight bearing upon the wheels, the weight to be moved, and the resistance from the friction of the train of waggons; so that no precise rule can be given that shall be applicable to roads and wheels of different materials and construction.

Knight makes a suggestion worthy of consideration in the construction of waggons, as well as engine-cars, that the weight should be supported on springs, for the purpose of distributing the weight equally. Another expedient, to secure a sufficient adhesion of the wheels to the surfaces of the rails, is to use wheels for the engine-car that are not case-hardened.

Experiments show a very great advantage in the use of large wheels. Some of the loco-motives used on the Liverpool and Manchester rail-road have sets of wheels of different sizes, the diameter of one being nearly double that of the other. The experiments of Booth prove that, in the most unfavourable state of the rails, the adhesion of wheels of malleable iron upon rails of the same material, is equal to 1-20th of the weight upon them. The locomotives vary in weight, from three or four to ten or eleven tons. A locomotive, with its apparatus and appendages, weighing four and a half tons, will adhere to the rails with sufficient force to draw thirty tons weight on a level road, at the rate of fifteen miles per hour, and seven tons up an ascent of one in ninety-six, or fifty-five feet in a mile; at a slower rate, it will draw a greater weight.

The curvatures of the rail-road present some obstructions, since, the axles of the car and waggons being usually fixed firmly to the frames, every bend of the tracks must evidently cause some lateral rubbing, or pressure of the wheels upon the rails, which will occasion an increased friction.

Knight's plan consists in a change in the form of the rim of the wheel. The part on which this rim commonly rolls on the rail is made cylindrical, this being the form of bearing evidently the least injurious to the road, as the weight, resting perpendicularly upon the rails, has no tendency to displace them or their supports. But between this ordinary bearing and the flange, a distance of about one inch, in a wheel of thirty inches diameter, he made the rim conical, rising towards the flange one-sixth of an inch, and thus gradually increasing in diameter. Wherever the road bends, the wheel, rolling on the exterior, and, in such case, longer track, will, in consequence of the tendency of the carriage to move in a right line, be carried up a little on the rail, so as to bear upon the conical part of the rim, which gives a bearing circumference of the wheel on that side, greater than that of the wheel at the opposite end of the same axle. The tendency, accordingly, is to keep the car in the centre of the tracks, by producing a curvilinear motion in the waggon, exactly corresponding to the curve of the road. If the diameter of the wheel is increased, that of the conical part of the rim should be increased also, making the rise of the conical part between the flange and the cylindrical part one-fifth of an inch in a wheel of three feet diameter, and one-fourth of an inch in a wheel of four feet diameter.

Knight describes a method of turning a very short curve of a quadrant of a circle on a radius of sixty feet, by making a plate with a groove for the flange of the wheel on the longer track to run in; thus, in this case, making the difference of the rolling circumference of the wheels correspond to that of the two tracks, for the purpose of turning corners of streets in towns.

Where the inclination of the road is greater than that for which the ordinary power is calculated, the ascent must be effected by means of an additional power. If, for instance, the additional inclination is one in ninety-six, or fifty-five feet in a mile, the additional power must be to the weight as one to ninety-six, or as fifty-five to the number of feet in a mile, namely 5280. In descending planes, so much inclined that the gravity would move the carriages too rapidly for safety, the velocity is checked by means of a break, which consists of a piece of wood of the same curvature as the rim of a set of the wheels, upon which the break is pressed by means of a lever, so adjusted as to be within reach of the conductor, in his position on the carriage.

The opinion, in favour of steam-power on roads, of which the inclination does not exceed about thirty feet in a mile, is fully established.

The advantages of this species of road are illustrated by the action of a horse upon it, compared with his performance upon the best turnpike, being, as Wood assumes, in one of his estimates, in the proportion of 7·5 to 1; thus enabling us to dispense with thirteen out of fifteen horses required for transportation on the best common roads. The horses' power of draught is much the greatest at a low rate of speed, since the more rapid the velocity, the greater proportion of his muscular exertion is required to transport his own weight. On the Baltimore and Ohio rail-road, a speed of ten miles an hour is kept up by horses, travelling stages of only six miles each.

The average consumption of coke by a locomotive-engine, on a passage from Liverpool to Manchester, thirty-two miles, is stated, by Mr. Wood, to be 800 lbs., and the water evaporated 225 gallons per hour, and 450 gallons on the passage. He computes that one of those locomotives will perform the work of 240 horses, travelling at the rate of ten miles per hour, upon a turnpike-road, the velocity of the locomotive being fifteen miles per hour. Stevenson estimates that the most advantageous speed is that of fifteen miles per hour for passenger trains, and seven miles for those transporting merchandise.

The rails used on the Liverpool and Manchester rail-way are made of forged iron, in lengths of five yards each, and weigh 35 lbs. per yard. Every three feet the rails rest on blocks of stone, let into the ground, containing each nearly four cubic feet. Into each block two holes, six inches deep and one inch in diameter, are drilled; into these are driven oak-plugs, and the cast-iron chairs or pedestals, into which the rails are immediately fitted, are firmly spiked down to the plugs, forming a structure of great solidity and strength. On the embankments, where the road may be expected to subside a little, the rails are laid on oak sleepers. For eighteen miles of the road the rails are placed on stone blocks, and, for the other thirteen on sleepers. The double line of rails for the carriages are laid down with mathematical correctness, and consist of four equi-distant rails, four feet eight inches apart, about two inches in breadth, and rising about an inch above the surface.

A reduction of the proportion of the bearing of the axles of railway-waggons, to the circumference of the wheels, causes a proportionate reduction of the friction.

With loaded waggons, the bearing part of the axles of which is only $1\frac{1}{2}$ in. diameter, the diameters of the wheels being about three feet, the friction is as 1 to 400, or 6 lbs. to the ton.

Though friction-rollers, at the axles of waggons, are, in some respects, advantageous, the great modern improvement consists in reducing the diameter of the axles.

On the Surrey railway 1 lb. power draws 60 lbs.; at Newcastle, on edge-rails, 1 lb. draws 176 lbs.; but, on the Penryn, with small wheels, only 87 lbs.

Liverpool and Manchester Railway.—At the Liverpool end, in the Company's yard, in Wapping, the lower entrance of the great Tunnel is accessible through an open cutting, 22 feet deep and 46 feet wide, being space for four lines of railway, with pillars between the lines to support the beams and flooring of the Company's warehouses, which are thrown across this excavation, and under which the waggons pass, to be loaded or discharged through hatchways or trap-doors, communicating with the stores above; waggons, loaded with coal or lime, passing underneath the warehouses to the open wharfs at the Wapping end of the station. Proceeding along the Tunnel, the line of railway curves to the right, or south-east, till it reaches the bottom of the inclined plane, which is a perfectly straight line, 1980 yards in length, with a uniform rise of three-quarters of an inch to a yard. The railway, from Wapping to the commencement of the inclined plane, is level; the whole rise, therefore, from Wapping to the tunnel mouth, at Edge-hill, is 123 feet. The tunnel is 22 feet wide and 16 feet high, the sides being perpendicular for five feet in height, surmounted by a semicircular arch of 11 feet radius: the total length is 2250 yards. The whole length of this vast cavern is furnished with gas-lights, and the sides and roof are white-washed. At the upper, or eastern end of the tunnel, the traveller emerges into a spacious area, 40 feet below the surface of the ground, cut out of the solid rock, and surmounted, on every side, by walls and battlements. From this area there rises a small tunnel, 290 yards in length, 15 feet wide, and 12 feet high, terminating at the upper and eastern boundary of Liverpool; being the principal station for the railway coaches, and the depôt for coals for the supply of the higher districts.

Proceeding eastward from the two tunnels, the road passes through a Moorish archway, which connects the two engine-houses, and is the grand entrance to the Liverpool stations. The traveller now finds himself on the open road to Manchester.

Over the great valley of the Sankey, with its canal at the bottom, and its flats or barges in full sail, the railway is carried along a magnificent terrace of nine arches, each 50 feet span, built principally of brick, with stone-facings, the height from the top of the parapets to the water in the canal being 70 feet, and the width of the railway, between the parapets, 25 feet. The immediate approach to Manchester is through a portion of Salford. Over the river Irwell, the railway is carried by a very handsome stone-bridge, and then over a series of arches, into the Company's station in Water-street and Liverpool-road, Manchester.

On the line between Liverpool and Manchester there are, besides, culverts and foot-bridges, 63 bridges, of which 30 pass under the turnpike-road, twenty-eight over it, four over brooks, &c., and one over the river Irwell. There are twenty-two of brick, seventeen of wood and brick, eleven of brick and stone, eleven of wood, and two of stone and wood. On the surface of the ground above the mouths of the tunnels, are built two lofty chimneys, in the form of columns, with handsome capitals; they are upwards of 100 feet in height, unique specimens of brickwork, and have an elegant appearance.

Along the line there are, at every mile and quarter of a mile, posts showing the distance from Liverpool to Mancester.

In the formation of the railway, there have been dug out of the different excavations upwards of three millions of cubic yards of stone, clay, and soil. The first expenditure of the Company, in actual payments, was 739,134*l.* 5*s.*; and, to finish the work, wallings, fences, warehouses, &c. a further sum of 80,834*l.* 15*s.* was necessary: making the whole sum expended above 820,000*l.*

Before the establishment of the Liverpool and Manchester railway, there were 22 regular and about 7 occasional extra coaches between those places, which, if full, could only carry, per day, 688 persons. The railway, from its commencement, carried 700,000 persons in 18 months, being an average of 1070 per day.

It has not been stopped for a single day, and there has occurred but one fatal accident on it in 18 months.

The fare, by coach, was 10*s.* inside, and 5*s.* outside. By railway, it is 5*s.* inside, and 3*s.* 6*d.* outside.

The time occupied in making the journey, by coach, was 4 hours. By railway, it is 1¾ hour.

All the coaches but one have ceased running, and that chiefly for conveyance of parcels. The mails travel by the railway. The railway coaches are more commodious than others.

A regiment of soldiers has been carried, by the railway, from Manchester to Liverpool, in two hours.

The rate of carriage of goods is 10*s.* per ton. By canal it used to be 15*s.* per ton. The time occupied in the journey, by railway, is two hours. By canal it is 20 hours. Goods are delivered in Manchester the same day they are received in Liverpool; and, by canal, they were never delivered before the third day.

The saving to manufacturers in the neighbourhood of Manchester, in the carriage of cotton alone, has been £20,000 per annum. Some houses of business save £500 a year in carriage.

Persons now go from Manchester to Liverpool and back, in the same day, with great ease; and, formerly, they were generally obliged to be absent the greater part of two days.

Coal-pits have been sunk and manufactories established on the line.

It is found advantageous for the carriage of milk and garden produce. Milk carried 15 miles at 1*s.* for 10 galls. A great deal of land on the line has been let for garden-ground.

Residents on the line find the railway a great convenience, by enabling them to attend to their business in Manchester and Liverpool.

The value of land, on the line, has been considerably enhanced by the operation of the railway; land cannot be had but at a large increase in price.

The scale of inclination to which a road is to be reduced, is necessarily taken into consideration in fixing upon a general route; but a choice often presents itself in parts of such a route, between the expense in reducing the rate of inclination by excavations and embankments, and the saving of expense by taking a more circuitous route.

In the recently-constructed rail-roads the iron rails are, in general, supported by iron chairs or props, at a distance of about three feet. Malleable iron rails, 15 feet long, were used on the Stockton and Darlington railway; over which locomotive-engines passed, weighing from 8 to 11 tons, and waggons, with their loads, weighing four tons. A rail 15 feet in length, weighing 136½ lbs. lost in the year 8 oz., or 1-272d part of its weight; but a cast-iron rail, four feet long, weighing 63 lbs. over which waggons passed, weighing four tons each, when loaded, lost 8 oz., being 1-126th part of the whole weight of the rail. Plate-rails were first used, which presented a flat surface to the wheel; but *edge-rails* have since come into use, and, according to Wood, are preferable, on account of their presenting less resistance to the wheel, and being less subject to injury by use.

In the tram railways, platrails are used, with a perpendicular plate, or rim, at the outside edge of the rail, of two or three inches in height, to confine the wheels upon the rail-road. But this mode of keeping the carriage upon the road is not necessary; for, whether the rail be of the plate or of the edge form, the wheels of the carriages may be confined to the road equally well by a flange, or projection at the periphery of the wheel, on the side next the centre of the road.

The rails join by lapping with what is called the *half-lap*, and fastening the ends of both rails by one pin; so that, although a chair should lean in the line of the road, or be a little depressed below the others, still the two rails would present a smooth surface at their junction.

An improvement, of great utility, has also been made in the mode of fastening the rails, by dispensing with the use of pins, which were liable to work loose. There are various forms of constructing the rails and chairs for this purpose. One mode is by making a depression in the chair on one side of the rail, into which a projection from its lower side precisely fits. If the rail is held close upon that side, it is thereby fixed to the chair, and can be moved only with the chair itself; and it is so held by driving a key, or wedge, along the opposite side of the rail, between the rail and the side of the chair projecting upon the side of the rail.

The supports, or chairs, are of iron, with a broad flat base, supported upon blocks of stone, into which holes are drilled, and filled with wooden plugs. The chairs are fastened to stone blocks, by nails driven into these plugs.

Losh recommends the dimensions of the bars meant to form the upper surface of a rail-way, calculated to carry locomotive-engines of seven or eight tons, and waggons of three or four tons weight each, to be fifteen or sixteen feet long, two and a quarter inches broad, and half to five-eighths of an inch thick. At every eighteen inches, or two feet of the length of this surface-plate, a tenon is firmly welded, or riveted; or, otherwise attached to the under side, taking care in this operation to leave the upper surface of the plate even as before. These tenons have holes through them in the transverse direction of the bars, to take a pin or rivet, of from about a quarter to half an inch in diameter: and at each extremity of the plate a tenon is fixed on by welding, having previously cut off a piece of about two inches long, and of half the breadth of the bar, from the opposite ends of the bar, or plate, and at the opposite angles, so that when two bars, so prepared, are brought to join at the ends, the joint is what is denominated a half-lap, or scarfed joint.

With reference to horse and steam-power, Anderson observes, that a waggon-horse with ease, under favourable circumstances, draws 20 tons. Fulton says, that five tons to a horse is the average work on railways, descending at the rate of three miles per hour; and one ton upwards with the same speed. Telford observes, that on a railway laid with a declivity of 50 feet in a mile, one horse will readily take down waggons containing 12 to 15 tons; and bring back the same waggons with four tons. Wilkes states, that a horse drew down the declivity of an iron road, 5 inches in 16 yards, 21 carriages or waggons, laden with coals and timber, weighing 35 tons, and the same horse, up this declivity, drew five tons with ease. On a different railway, one horse drew 21 waggons of five cwt. each, which, with their loading of coals, amounted to 43 tons 8 cwt., down the declivity of 1 inch in three yards; and he afterwards drew 7 tons up the same; the cwt. being 120 lbs.

Sylvester states, that a moving force, which will give the velocity of 5 miles an hour, or 22 feet in 3 seconds, will be performed *down* a plane, 1 inch in 9 yards, or 1 in 324, by the engine making 45 strokes per minute, (the circumference of the wheel being nine feet), with a pressure of 9·7 lbs. upon an inch, of each of the two cylinders, the area of each being 63·6 square inches. The weight of the engine and 16 waggons is equal to 154,560 lbs., or nearly 70 tons.

If the same weight, at that speed, had to move on *a dead level*, and acquired the same velocity in one minute as before, the moving force would require to be 1781 lbs. which would require a pressure of 13·7 lbs. upon one inch. But after the speed is obtained, it will require only 7 lbs. to keep it moving at the same rate.

If the same load were required to move *up* the plane, it would require a moving force of 2328 lbs., or a pressure upon every square inch of 18·3 lbs. And this velocity would be kept up by a constant pressure of 1447 lbs., which will be 11·3 lbs. upon every inch of the piston.

When the engine is required to travel at the rate of nine miles per hour, the force necessary to overcome the weight 154,560 lbs. will be for the first minute, when the engine is travelling on a level, 2890·81 lbs.; when moving down the plane 2461·61 lbs.; and, when moving up the plane 3320·01 lbs. But that, when the velocity is attained, a force that will balance the friction is sufficient to keep up the required velocity. This force is, for travelling on a level, 900 lbs.; for moving down the plane, 471 lbs.; and for moving up the plane 1329 lbs.

A *boat* weighing with its load 15 *tons, and a waggon of the same weight*, the one on a canal, and the other on a railway, would be impelled at the following rates, by the following quantities of power—in pounds and in horse-power—reckoning one horse equal to 180 lbs.

*Canal.*

| Miles per h. | In pounds. | Horse power. |
|---|---|---|
| 2 | 33 | 0·2 |
| 4 | 133 | 0·66 |
| 6 | 300 | 1·75 |
| 8 | 533 | 3 |
| 12 | 1200 | 7 |
| 16 | 2133 | 12 |
| 20 | 3325 | 18 |

*Rail-way.*

| In pounds. | Horse power. |
|---|---|
| 100 | 0·5 |
| 102 | 0·5 |
| 105 | 0·5 |
| 109 | 0·5 |
| 120 | 0·66 |
| 137 | 0·75 |
| 158 | 1·— |

The force required to keep a given weight in motion does not vary with the velocity: thus, a force of 14 lbs. was found to overcome friction, and keep in motion an empty coal-waggon, weighing 23·25 cwt. on a rail-road; but that, on doubling the velocity, no more force was required. Further, on increasing the weight, or load, the power required to overcome the friction, and keep the waggon in motion, did not increase in similar proportion, but up to 76·25 cwt. was about 1-14th less.

When rail-ways are to be made in districts where a level cannot be approximated, the carriages are raised up ascents by fixed steam-engines, or horse-wheels at the summits by chain-cables, and lowered in like manner. In this way a fine rail-way has been made by Jessop, to pass from the mines of Derbyshire to the summit of the hills; and, in this manner, rail-roads might be constructed over the Alps and Andes. When at the summit, they pass on its plateau in the usual way.

RAISINS, are dried grapes, sometimes by cutting the stalk half through, and leaving them to dry on the vine; and at others by dipping the bunches in ley of the tendril ashes, and then spreading them in the sun to candy.

RALEIGH'S CORDIAL.—In 3 pints of alcohol infuse 1 lb. of each of rosemary, spikenard, and juniper, ½ a lb. of saffron, lesser cardamoms, and zedoary; strain, evaporate 1-6th, then add 2 lbs. of white sugar, 1 oz. of cloves, 2 oz. of cinnamon and of nutmegs, and 16 oz. of purified chalk.

RANCIDITY, is the change which oils undergo by exposure to the air. Fixed oil, exposed for a certain time to the open air, absorbs oxygen, and acquires a peculiar odour of fire, an acrid and burnt taste, at the same time that it becomes thick and coloured; but oil is not subject to alteration in closed vessels. The rancidity of oils is, therefore, an effect analogous to the oxydation of metals. It essentially depends on the combination of oxygen with the extractive principle.

RASPBERRY JAM.—Boil equal weights of white sugar, and of picked raspberries, till a skin forms after blowing.

RASPBERRY SHERBET.—Raspberry vinegar ½ an oz. in a half pint tumbler of water.

RASPBERRY VINEGAR.—To 2 pints of vinegar add 3 lbs. of raspberries, and 3 lbs. of white sugar. *Or*, In 3 pints of white-wine vinegar steep, for 24 hours, 3 half-pints of raspberries, then strain them out, and twice more repeat the quantity. To each pint of liquid add 1 lb. of refined sugar, carefully boil and skim 1 hour; and, when cold, add alcohol, or brandy, 2 oz. to each pint.

RASPS, for potatoes, and for beetroots, have been invented in France, by Barette and Odobel, to facilitate the pulverization of those roots, by which incredible quantities of pulp for pressure are prepared with little manual labour in a short time.

RATAFIA, *(De Genievre.)*—In 4 pints of alcohol mix 10 lbs. of sugar, and 2 oz. of dried (not bruised) juniper-berries. *Or, (De Noyaux)* in 4 pints of alcohol mix 10 lbs. of sugar, and 120 peach or apricot kernels, bruised.

*Ratafia of Grapes, without sugar.*—Take the sweetest grapes, and put them into a bottle without the stalks, with good French brandy. Cork the bottle, and leave them to infuse during a fortnight. Then pour out the grapes and brandy into a dish; bruise the grapes, and pass the whole through a close cloth. Put the liquor into a glass bottle well corked, adding a little cinnamon, and some peach-kernels, and leave it for another fortnight, when it is to be poured clear off, or clarified.

RATANY ROOT, brought from Peru, is a very efficacious astringent, relieving dysentery in its worst stage, also a styptic important in internal bleeding, and highly useful as a dentifrice. As a stomachic it is used with great success. 10 grs. or ½ a dr. is a dose. It is used as a tincture, or extract, and as a tincture is digested with an equal weight of orange-peel, serpentaria, and saffron.

REALGER, a red sulphuret of arsenic, is made by the slow fusion of metallic arsenic, of white arsenic, and sulphur.

RECIPE, is the Latin word for *take*, as the beginning of an instruction, or prescription, and is usually written as an R with a stroke through, or by many is made a character like ♃.

REEFING, consists in binding a portion of the sails to their respective yards, so as to reduce the surface. To reef the top-sails, we clew the yards down, haul up the sides of the sails by means of reef-tackles, and brace the yards to the wind, until the sail shiver and spill; then the men go out on the yard, and, by means of the earings and reef-points, securely bind the requisite portion. When the top-sails are double-reefed, it is time for the jib to come in to relieve the jib-boom and fore-topmast of the pressure: to counterbalance the loss of this head-sail, the mizen-top-sail may be furled. When the top-sails are close-reefed, the main-sail is either reefed, or furled. As the gale increases, furl the fore-top-sail; taking care to draw up the weather-clew first, that the sail may not be in danger of shaking and blowing away.

RECEIVER.—Receivers are chemical vessels, which are adapted to the necks or beaks of retorts, alembics, and other distillatory vessels, to collect, receive, and contain the products of distillations. Receivers ought to be made of glass, not only because this matter resists the action of the strongest and most corrosive substances, but also because, being transparent, it allows the operator to see through it, and to judge by the frequency of the drops, whether the distillation proceed too fast, or too slow, and, also, whether the quantity and nature of the substances which come over be such as are required.

REDDLE, or Red Chalk, an ore of iron in the state of red oxide, commonly used as a pigment. Red-lead pencils, as they are vulgarly called, are made of this substance.

REDUCTION, or REVIVIFICATION.—This word, in its most extensive sense, is applicable to all operations by which any substance is restored to its *natural* state, or what is considered as such.

The reduction of metallic oxides, by fusion, is generally a quick and easy operation. It, however, requires certain attentions and management.

1. To mix, accurately, the metallic oxide to be reduced, with the proper quantity of the combustible matter which is to reduce it.

2. To add to the mixture some saline, or vitreous matter, capable of facilitating the fusion and separation of the reduced metal from the scoria.

3. To prevent any communication with external air, that the inflammable addition may not be burnt and consumed.

4. To keep the fire low at first, that the too great swelling, which is generally occasioned by the extrication of volatile or elastic matter, may be prevented; and to raise the fire toward the end, so that not only the metal, but also the supernatant scoria, may be perfectly fused. For, if the scoria was not well fused and tenacious, it would retain much of the reduced metal, and prevent it from falling down to the bottom of the crucible.

The operations must be very exactly performed, especially in assays of ores, in which the precise quantity of metal is required to be known. These assays of ores are in some measure the only reductions of this kind, which are performed in practical chemistry, as the reduction of pure metallic oxides differs from the former in only requiring a less quantity of flux; because these oxides do not, as the ores do, contain a difficulty, fusible, earthy, or stony matter.

Fulminating gold may be reduced by fusing it with sulphur, or with fixed alkali; because either of these substances is capable of separating the ammonia, which gives the fulminating property to gold.

Luna cornea also is reduced, by fusing it with a large quantity, as for instance with twice its weight of fixed alkali; because, in this reduction, the muriatic acid, united with the silver, is to be separated, and the fixed alkali is capable of effecting that separation.

The mercury of cinnabar is to be reduced, or separated from sulphur, by mixing with the cinnabar any substance which has greater affinity with sulphur than mercury has; such as fixed alkalies, absorbent earths, iron, copper, lead, silver, or antimony. Filings of iron are generally employed in this operation, an equal weight of which is to be mixed with the cinnabar, and the whole distilled together.

REFINING, is a term used in chemistry, and several arts, to signify the purification of some substance, particularly of metals, as gold, silver, copper, iron, &c.

Gold, having the property which no other metal, not even silver, has, of resisting the action of sulphur, of antimony, of nitric acid, of muriatic acid, may be purified by these agents from all other metallic substances, and consequently may be refined.

As none but the perfect metals can resist the combined action of air and fire, without being oxyded, and thus changed into earthy, or vitreous matters, incapable of remaining any longer united with substances in a metallic state; there is a possibility of purifying gold and silver from all alloy of imperfect metals, merely by the action of fire and air; only by keeping them fused till all the alloy is destroyed.

But a much shorter, and more advantageous method has been discovered. This method consists in adding to the alloyed gold and silver a certain quantity of lead, and in exposing afterward this mixture to the action of the fire. Lead is one of the metals which are most quickly and easily oxided; but at the same time this metal has the remarkable property of being very easily melted into a vitrified and powerfully-vitrifying matter, called litharge.

The vessel in which the refining is performed is flat and shallow, that the matter which it contains may present to the air the greatest surface possible. This form resembles that of a cup, and hence it has been called cupel.

REFRACTION, is the turning aside of light from the right when it passes out of one medium into another. On entering a dense medium, it is bent towards the perpendicular to the surface, resisted, or turned back in degree; whereas, on passing into a rare medium, it is elevated, and indicates more freedom. It is just such a mechanical effect as would arise from any rectilinear force, which would act, or be acted up, just in the same manner.

Of course, the red, &c. vibrations or rays, as the most power are least turned aside; while the violet, &c. suffer the greatest deflection.

This affection of light is the foundation of spectacles, lenses, &c. whose regular refractions from their convex surface produce images of objects before them. In this respect, nature affords a striking lesson in the crystalline lens of the eye, which our lenses do but imitate.

Double refraction, in calcareous spar, is ascribed, by Huygens, to the undulations of light assuming the spheroidal form in passing through the spar. The Editor has suggested, that light, in passing through transparent medium in general, makes a multitude of regular reflections, through the illumined mass of which the principal ray is the centre, but that in spar the rhomboidal crystals are merely so arranged and formed as to produce two sets of reflections and two sets of crystals, instead of the cube and octohedron of common images. In this sense, refraction is to be regarded as a result of atomic reflections, and since the angle of reflection varies as that of incidence, and that of refraction also, the latter is explained by the former. Without *definite* distance and *regular* structure, the body is opaque, and permits no light to pass through it, and except by continued reflection, *penetration* of solid diaphonous bodies seems to be *an impossibility*. It may also be supposed, that transparent bodies contain the matter of light parallel to their surfaces, and that these may be affected with the mass. The passage of identical rays seems, however, to be *an impossibility*, except by reflections, and this would also explain double refraction and polarization.

Taking the refraction of a vacuum at 1, that of air is 1·00033, of water is 1·336, (ice 1·31) of Iceland spar 1·488 and 1·657, plate-glass 1·5, crown-glass 1·525, flint-glass 1·584, carbonate of sulphur 1·68, diamond 2·755.

Taking air as 1, oxygen-gas is 0·862, hydrogen 6·6, and nitrogen 1·03; carbonic acid gas 1·00476, ammoniacal gas 2·1683.

The prismatic image has various lengths for various substances, called their dispensive power. Taking that of flint-glass at 1, that of water is 0·7, that of fluor spar 0·43, and so for others.

RECTIFICATION, is a second or third distillation, but at a lower heat, and is accompanied by flavouring processes, for giving flavours and odours to compounds and cordials.

REFINED LIQUORICE, is made by

gently evaporating a solution of liquorice with half its weight of gum arabic, rolling it, and polishing by friction in a box.

RENT, is a consideration paid by a tenant for those improvements which have raised the land above the state of nature, as for buildings, fences, drainage, planting, manuring, &c. The amount of these expences, incurred or transferred, constitute the right of the landlord. It is true, that, at the Conquest, the Norman tyrant gave all the rights of landlords to his foreign followers, but this made no difference to the tenantry, or in the relations of a tenant to some landlord. The change was rather an advantage, since the great Norman barons seldom exacted more than a 30th or 40th of the produce. But, in the reign of Henry VIIth., a power of alienation was given, and from that time land has become an object of commerce and speculation. Rents, in consequence, rose to an eighth or tenth of the produce in the seventeenth century, and, in the latter part of the eighteenth century, to a fourth and fifth. Latterly, a fourth has been generally exacted, and, on large and productive farms, as high as a third, landlords during the war taking advantage of high prices, and of the farming mania which prevailed for 20 or 30 years. Two guineas per acre is now the average rent for land, which, at the revolution, let for only 2*s*., and most good land, within a few miles of large towns, is let at 4 and 5 guineas, of which the rent, within a century, was but 4*s*. or 5*s*. At present, tenants are paying rents out of their capital, not out of their profits. In fact, no rent ought to be allowed to exceed a fourth or fifth of the average profits of a previous term of 4 or 5 years.

Besides his rent, an English farmer has to pay, for tythes, rates, and taxes 53 per cent. more. So that if he pay 25*s*. rent, he has 13*s*. 3*d*. in fixed payments; or, if his rent is 50*s*. he has 26*s*. 6*d*. to pay over and above; besides paying duties on all articles of consumption, equal to a fourth of his family expenditure.

RESILIENCE, is the power of resisting a body in motion, and a term often used in mechanics.

RESISTANCE of fluids is a very important consideration, and arises from a moving body parting with motion to atoms in its course. In mechanics, in general, it is as the square of the velocity but greater in large surfaces. Thus, square surfaces of 9, 16, 36, and 81, gave resistances of 9, $17\frac{1}{3}$, $42\frac{3}{4}$, and $104\frac{3}{4}$. The impulse of wind, at 1 foot per second per square foot, is one 500th of a pound, and for other velocities is to that as the square of the velocity. By experiment, 10 feet per second of 1 square foot is 0·129 lbs., of 30 feet per second 5·718 lbs., and of 150 feet 51·462 lbs. Resistance is also nearly as the surface. An iron ball of 2·78 inches, or 3 lbs. weight, in a velocity of 1800 feet per second, experiences a resistance of 176 lbs.—*Gregory*.

A ball 1·965 diameter, with a velocity of 20 feet per second, has a resistance, by experiment, of 0·1; of 100 feet, 2·72; of 500 feet, 72 feet; of 1000 feet, 350 feet; and 2000 feet is 1569 feet.

A plane at 5°, 0·015; at 20°, ·133; at 45°, ·534; at 60°, 0·729; and at 90°, 0·84.

The resistance of the air on a falling body is such, that the accelerated motion will not increase the velocity of an iron ball of 1 lb. above 244 feet per second, nor one of 42 lbs. above 456.

RESIN; a vegetable substance, which exudes from many trees, either from fissures, or wounds. Common resin, or rosin, is obtained by distilling the exuded matter of pine. Oil of turpentine passes over, and the resin remains behind. Resins are insoluble in water, but soluble in alcohol; and inodourous, though they sometimes derive odour from containing an essential oil. They consist chiefly of carbon, with about one quarter of hydrogen and oxygen.

RESPIRATION; the alternate inspiration and expiration of atmospheric air, for the purpose of bringing it into contact with the blood, and exchanging the nitrogen and carbon, with which it is charged, for oxygen. This function is therefore closely connected with that of life, and the circulation of the blood. The organs and mechanism vary considerably in different classes of animals. In the mammalia, birds, and reptiles, the organ of respiration is the lungs; in fish, in the gills; in most insects, in the trachea; and in the lower classes of animals in different parts of the system. The air, being brought into contact with the blood, is decomposed; its oxygen is united with the blood, and its nitrogen is returned by expiration, unchanged, with an additional quantity of carbonic acid gas. Another part of the oxygen unites with the superfluous carbon in the blood, and forms carbonic acid gas, which passes off with some watery vapour. Oxygen gas, therefore, is necessary to animal life. Upon respiration depends animal heat, which is a transfer of the motions of the atoms of oxygen to the blood and system. The mechanical act of respiration is effected by the motion of the ribs and diaphragm. In the natural state, the ribs are inclined downwards, and when this series of moveable hoops is raised by the action of the muscles, the cavity of the chest is enlarged. The descent of the diaphragm, by its contraction, increases this effect, and the air, therefore, rushes in to fill up the vacant space: the ribs then descend, and the diaphragm rises, and the air is necessarily driven out, in consequence of the resulting contraction of the chest. About twenty respirations take place in a minute, and from thirty to forty cubic inches of air are inhaled at each respiration. A man consumes about a third of a cubic foot of air in a minute.

On the commencement of *catarrhal affections*, it has generally been found the best means of insuring a speedy recovery, at once to desist from meat, beer, or wine, and to remain in bed for a day, with the following medicines: Take 5 grs. James's powder, and 2½ grs. of calomel. Mix. Two grs. of camphor, or ½ gr. of opium, to be added as circumstances may require: drinking freely of toast and water.

*For Coughs.*—To 7 table-spoonfuls of treacle or honey add 7 table-spoonfuls of vinegar. Let them be boiled and skimmed, and put into a bottle till cool. Then add from 100 to 150 drops of laudanum. A table-spoonful to be taken at night, and a tea-spoonful in the morning.—*Or*, Take 6 oz. of Italian liquorice, cut into small pieces, and put into an earthen jar, with a quarter of a pint of the best white-wine vinegar; simmer, until the liquorice is dissolved, then add 2 oz. of oil of almonds, and ½ oz. of tincture of opium; stir the whole, and take 2 tea-spoonfuls when going to bed, and whenever the cough is troublesome.—*Or*, A mixture composed of half a pint of spring-water, and a quarter of a pint of sweet oil, with two tea-spoonsful of hartshorn, and a little fine sugar to sweeten it. The bottle must be shaken every time a spoonful or two is taken.—*Or*, Dilute and mix, by the fire, honey and vinegar, and take occasionally.

*Or*, Over a peck of pale ground malt pour eight to nine quarts of hot, not boiling, water. Stir it well, and cover it close. Let it stand 48 hours, then strain it through a hair-sieve, but without squeezing, and put the liquor over a gentle fire, till it comes to a syrup as thick as treacle, stirring and skimming; then put it into tied jelly-pots. A tea-spoonful to be taken fasting in the morning, on going to bed, and oftener if necessary. Common beer-wort answers, but requires a great deal more boiling to reduce it to the thickness of treacle.

*Or, sudden hoarseness.*—A tea-spoonful of sweet spirit of nitre, (*spiritus ætheris nitrosi,*) in a glass of water, may be taken at any time. It is cooling and diuretic.

Many persons have found benefit, when the breathing is difficult, from taking a tea-spoonful of hartshorn, in a small basin of gruel, at bed-time.

*For the Asthma.*— A large cup of strong coffee, without milk, affords temporary relief.—*Or*, As a remedy, take of Battley's sedative 15 drops, lemon-juice 3 drs., and mix with a drachm of syrup. Take of the super-carbonate of soda, distilled water, 9 drs. Mix the two, and drink while effervescing.

RESTORATIONS.—To restore the colours of carpets, dust them, and rub them with a dry brush. Then brush them with soap lather, which wash off with water, and finish with alum water, made by dissolving a pound in two gallons of water with a little gum-arabic.

To restore the colours of cloth, brush it with water, in a quart of which add 2 oz. of quicklime, and 2 of oak-bark. To restore silks, spunge them with a similar lye, and put half vine-ashes for half the oak; heat it, and let it settle.

In the fine arts, it signifies the repairing of the injury suffered by works of art, statues, pictures, &c. Even in ancient times, statues were restored, as, during the civil wars, many were injured. There are now, in Italy, some very skilful restorers of paintings. It often requires the eye of a perfect connoisseur to discover restorations, and not a few remarks on the character of ancient art have been founded on undetected restorations.

*To remove Spots from Cloth.*—Pour a quart of warm water into a glazed earthen pan, and add a small quantity of white soap, and an ounce of powder of kali of Alicant: when this is thoroughly dissolved, add two-spoonsful of ox-gall, and a little essence of lavender; let the whole be well-stirred, and strained through a linen cloth, and kept in a bottle. A small quantity is to be placed with care on the spot, which is to be rubbed with a small brush, and then washed with warm water.

*To remove Stains of Oil upon Satins, Stuffs, or Paper.*—Take the burnt ashes of bones, and put them warm over and under the part stained; place thereon a weight, and let it remain for one night. If the stain be not thoroughly effaced, repeat the operation till it disappears. This powder, if the weight be left upon the part too long, will even efface printed characters from paper.

*Restoring Silk, &c.*—Take raw potatoes, and grate them to a pulp over water; pass the liquid through a coarse sieve into a tub of clear water; let the mixture stand until the particles, (or starch) are precipitated; then pour off the liquor for use. Lay the article to be cleaned over a linen cloth upon a table, and with a sponge, dipped in the potato-liquor, wet and rub the article to be cleaned, repeating the affusion till the dirt is loosened; wash the article in clean water repeatedly; then dry and smoothen. Two middle-sized potatoes are sufficient for a pint of water. The white powder, or starch, separated from the liquor at the bottom of the tub, after being washed by repeated affusions of water, forms an excellent substitute for tapioca, as nourishing food with soup or milk. The coarse pulp which does not pass the sieve is of great use in cleaning worsted or woollen curtains, tapestry, carpets, or other coarse goods. The liquor cleans the finer kinds of silk, cotton, and woollen goods, without injury to the texture or colours, and is useful in cleaning oil-paintings, or soiled furniture. Dirty painted wainscotting is also effectually cleaned by wetting a sponge in the liquid, and rubbing it with a little fine sand over the wainscot.

RETORTS, are round or oval vessels with necks, to convey products of distillation to a receiver; and, in cases of danger of explosion, their tops are fitted with a bent or doubled tube, to permit the escape of any explosive gas, without losing any product.

REVERSING MOTION, is a very important principle in mechanics, and in a general way, says Gregory, is effected "by making two equal pinions on one and the same axis, turn alternately into the teeth of those parts of a larger wheel which are nearly diametrically opposite; or, by means of an additional wheel, which may be thrown in or out of gear alternately."

RHEUMATISM, is distinguished into *acute* and *chronic*. The former is of short continuance, and either shifting to different parts of the body, or confined to a particular part: in the latter case, it has a tendency to pass into the chronic, unless properly attended to: it is often attended with fever, or sometimes comes on in the train of a fever.

Chronic rheumatism is attended with pains in the head, shoulders, knees, and other large joints, which, at times, are confined to one particular part, and at others shift from one joint to another, without occasioning any fever. It is divided into three species; *lumbago*, affecting the loins; *sciatica*, affecting the hip; and *arthrodynia*, or pains in the joints. Obstructed perspiration, occasioned either by wearing wet clothes, lying in damp linen, or damp rooms, or by being exposed to cool air, when the body has been much heated by exercise, are causes which usually produce rheumatism.

The preventive is daily washing in cold (or even tepid) water, and thoroughly rubbing all over with very rough towels or a flesh-brush.

*Rheumatic Infusion.*—In 1 pound of honey mix 1 nutmeg, 2 ounces of flour of sulphur, 1 ounce of cream of tartar, 2 drachms of rhubarb, and 1 drachm of guaiacum. Take two table-spoonfuls daily.

A decoction of the leaves of rhododendrum chrysanthum, of 2 drs. in 12 oz. of water is a specific for rheumatic gout, operating like *Eau Medicinale.*

So also the tincture of colchicum, but they should be resorted to only under medical superintendance.

*Anti-rheumatism Embrocation.*—Mix sal volatile three parts, with laudanum one part.—*Or*, Mix 1 oz. of the spirits of turpentine, 1 oz. spirits of hartshorn, 1 oz. of opodeldoc.

*Rheumatic or Gouty Swellings.*—The proportion to be half a pint of brandy, a quarter of a ℔. of black soap, 2 oz. of camphor, heated over the fire till it forms an ointment. To be applied to the parts affected with flannel, and frequently rubbed in.

RHODIUM, a combination of platina, white, and very hard, with sp. gr. of 10·649. It alloys with steel.

RHUBARB.—The officinal, or true rhubarb, grows wild along the frontiers of China. It is usual with the Chinese, when the roots have been taken from the ground, cleaned and pared, to cut them in slices, and lay them upon long tables, taking care to turn them three or four times a day, experience having taught that, if exposed to a free current of air, they become light, and lose a portion of their strength. After the fourth day, they are perforated and strung upon cords, in such a way as not to touch each other, and are suspended to dry in the shade, either upon trees, or in tents. In about two months the roots have lost seven-eighths of their weight, and are fit for market.

It is only within a few years that the officinal rhubarb has been successfully cultivated on a large scale in Europe. It is most readily multiplied by planting pieces of the root, containing eyes, 30 or more of which are afforded by a root four or five years old. They are planted early in the spring, after leaving them exposed to the air for a day, that cicatrices may be formed. They should be placed in quincunx order, about six feet apart. To cut or break the stems, about a foot from the ground, is very often advantageous. The plant may remain in the ground all winter, but during severe frosts should be covered with straw or dry leaves. The roots are taken from the ground only after the fourth or fifth year, but sooner in a dry and warm soil than in a moist and cool one; when taken up too soon, their substance is soft, and will lose 11-12ths in drying.

The common garden rhubarb has obtuse smooth leaves, with hairy veins beneath. It is chiefly in request for the stalks of the leaves, which, when young, are used for pies and tarts.

The leaves impart an agreeable acidity, somewhat similar to that of sorrel; and a marmalade is made from the fresh stalks, by stripping off the bark, and boiling the pulp with an equal quantity of sugar.

Rhubarb, by chemical analysis, is found to contain gum, resin, extractive, tannin, gallic acid, and oxalic acid. It is at once cathartic and astringent, as the dose is large or small; and it may be combined with alkalies and bitters.

RHUBARB, TINCTURE OF, is made by digesting 3 oz. of sliced rhubarb and ½ oz. of bruised cardamoms in 3 pints of proof spirit for seven days. The compound tincture has some liquorice-root, ginger, and saffron added, instead of 1 oz. of the rhubarb.—*Or*, 1 oz. of gentian may be substituted for a stomachic, or senna-leaves for colic or gout cordial.

RHUBARB PILLS.—Mix 1 oz. of rhubarb and 2½ drs. each of jalap and vitriolated tartar, ½ dr. of oil of nutmeg, and sufficient extract of gentian.

RIB.—The ribs are long curved bones, placed, in an oblique direction, at the sides of the chest. Their number is generally twelve on each side; but, in some subjects, it has been found to be thirteen, and in others, though more rarely, only eleven. They are distinguished into *true* and *false* ribs. The seven upper ribs, which are articulated to the sternum, are called true ribs, and the five lower ones, which are not immediately attached to that bone, are called false ribs. The use of the ribs is to give form to the thorax, and to cover and defend the lungs; also to assist in breathing; for they are joined to the vertebræ by regular hinges, which allow of short motions, and to the sternum by cartilages, which yield to the motion of the ribs, and return again when the muscles cease to act.

RICE *(oryza sativa)* an important article of food in all the warmer parts of the globe. In Britain, the chief supply of rice is from Carolina; and it is considered far superior to the Indian rice. Immense districts would remain desolate and irreclaimable, if this simple grass had not the property of growing exclusively in inundated and marshy grounds. It is to this grain that the Chinese and Hindoos owe their early civilization. An immense population is dependent on the rice crops; and, when these fail, thousands perish of hunger. The culm of the rice is from one to six feet high, annual, and jointed; the leaves are large, firm, and pointed, arising from very long, cylindrical, and finely-striated sheaths; the flowers are disposed in a large and beautiful panicle, somewhat resembling the oat. The seeds are white and oblong, but vary in size and form in the numerous varieties. The Hindoos, Chinese, Malays, and the inhabitants of the neighbouring islands, have paid most attention to the cultivation of these varieties. In warm climates, it is said to yield six times as much as the same area of wheat lands. The Chinese obtain two crops a year, and cultivate it from generation to generation on the same soil, and without any other manure than the mud deposited by the water of the river. After the waters have withdrawn, a few days are allowed for the mud to become partially dry; then a small spot is enclosed by an embankment, lightly ploughed and harrowed, and the grain, previously steeped in dung diluted with animal water, is sown very thickly on it. A thin sheet of water is immediately brought over it, either by a stream or the chain-pump. In the mean time other spaces are preparing for being planted in a similar manner. When the plants are six or seven inches high, they are transplanted in furrows made by the plough, so as to stand about a foot apart: water is then brought over them, and kept on till the crop begins to ripen, when it is withheld; so that, when the harvest arrives, the field is quite dry. It is reaped with a sickle, threshed with a flail, or the treading of cattle, and the husk is taken off by beating it in a stone-mortar, or passing it between flat stones, as in a common meal-mill. The first crop being cut in May, a second is immediately prepared, by burning the stubble, and this second crop ripens in October or November. After removal, the stubble is ploughed in, which is the only vegetable manure such lands receive.

RICE-PAPER.—The substance called in England "rice-paper," is made of the branch of the plant, in China.

Mr. Gill remarks, that, the so-termed "Chinese rice-paper" is an organized vegetable production, much resembling, in its structure, the pith of elder. He thinks cylindrical pieces of elder, or other pith, might be found in this country, quite large enough to bear slicing in this manner; and which slices, after being flattened, by pressure between plates (possibly warmed or heated) might serve as substitutes for the Chinese ones; and be as capable of receiving any colours for flowers.

RIGA BALSAM.—Add 1 lb. of the early spring shoots of Scotch fir to a gallon of alcohol. The dose is stimulant and diuretic; and vulnerary, applied externally.

RING-WORM, a very obstinate disease, is relieved or cured by zinc ointment, made of 2 lbs. of white wax, and 3 oz. of oxide of zinc.—*Or*, 6 oz. of hogs' lard and 1 oz. of oxide of zinc.

ROADS.—The improvement of roads has long been a subject of great interest with the agricultural and commercial inhabitants of Great Britain. But all discussion about roads has been superseded by M'Adam, whose leading principles are, that a road ought to be considered as an artificial flooring, forming a strong, smooth, solid surface, at once capable of carrying great weights, and over which carriages may pass without meeting any impediment.

The stones already in the road are to be loosened and broken, so that no piece may exceed *six ounces in weight*; the road is then to be laid as flat as possible, leaving only a fall of *three inches* from the middle to the sides, when the road is thirty feet wide. The stones thus reduced must not be laid on in shovels full, but scattered, and one shovel full spread over another.

Only a small part of the length of the road should be prepared in this manner at once; that is, about two or three yards; five men, in a gang, should be employed to prepare it all across, two continually digging up and raking off the large stones, and preparing the road for receiving them again, and the other three breaking them at the side of the road.

The only proper method of breaking stones, in general, both for effect and for economy, is, by sitting on straw mats. The stones are to be placed in small heaps, and women, boys, and old men past hard labour may sit down and break them, with small hammers, into pieces not exceeding *six ounces in weight*. But, in wet weather, they should be provided with an awning of strong sail-cloth, and even in intensely hot weather, it being found that, with such accommodation, twice the work may be performed.

It is always superfluous, and generally injurious, to add to the broken stone any mixture of earth, clay, chalk, or any other matter that will imbibe water, and be affected by frost; or to lay any thing whatever on the clean stone for the purpose of binding it; for good stone, well broken, will always combine, by its own roughness, into a solid substance, with a smooth surface, that will not be affected by the vicissitudes of weather, or disfigured by the action of wheels, which, as they pass over it without a jolt, will, consequently, be incapable of doing it any considerable injury.

The whole expense of preparing and newly-forming a rough road, to the depth of four inches, has generally been from a penny to twopence per square yard, being more or less, according to the quantity of stone to be broken. With proper tools, and by proper arrangements, stone may be broken for a shilling per ton.

Mr. M'Adam maintains, that the quantity of stone required for paving is fully sufficient to make an excellent gravel-road in any part of the world: and, in almost every case, materials equally good can be obtained for roads at a much cheaper rate; commonly, indeed, at one-tenth of the expense of pavements. On this principle, all the bye-streets, and nearly all the great thoroughfares, in London, and nearly in every town, have been, within 10 years, M'Adamized; and the roads, in general, wonderfully improved.

The objection to a very convex road is, that travellers only use the middle of it, which is, therefore, worn into three furrows by the string of horses, and by the wheels; if the road is flatter, it becomes worn more equally. Ditches (he observes,) only require to be so deep that the surface of the water in them may be a few inches below the level of the road; the farmer often makes them dangerously deep, on account of the value of the mould that is dug out of them. Mr. M'Adam would prefer a bog to any other foundation for a road, provided that it would allow a man to walk over it; and the resistance to a carriage would not be materially affected by the foundation, if the road were well made. He does not use faggots, nor any stones larger than six ounces in weight; and these never sink in a bog, but unite into one mass like a piece of timber, which rests on it. He makes such a road, generally, at three different times: and he always prefers working in weather not very dry. Clean flints from the sea-side are among the best materials for roads. Granite chippings, brought as ballast, are also excellent.

Mr. Bevan has published results of some experiments on the actual force of draught of carriages upon common roads, all made, or reduced to roads perfectly level or horizontal, to separate the mechanical force due to the inclination of the hill or plane from the force necessary to overcome the friction of the carriage, in its ordinary state, as affected by the condition of the road; and, by way of rendering them comparable with other experiments, which have been, or may yet be, made on this subject, he considered the gross load of the waggon and burden to be divided into 1000 parts.

Loose sandy road, force of draught 204 or 1-5th.

Turnpike-road, new gravelled, mean 143 or 1-7th.

Ordinary bye-road, mean 106, nearly 1-9½.

Hard compact loam, mean 53, nearly 1-19th.

Dry hard turf, mean 40 or 1-25th.

Turnpike-road, with a little dirt, mean 34½ or 1-29th.

Turnpike-road free from dirt, mean 30¼ or 1-33d.

From which it appears that *five* horses will draw with equal ease the same load upon a good hard turnpike-road, as *thirty-three* horses can do upon loose sand! Or, if we assume the value of draught, upon a well-formed road in good condition, at sixpence per ton per mile, the equivalent price will be

| | *s.* | *d.* |
|---|---|---|
| Upon hard turf | 0 | 7¼ |
| hard loam | 0 | 9½ |
| ordinary bye-road | 1 | 7 |
| newly-gravelled road | 2 | 2 |
| loose sandy road | 3 | 1 |

On hard smooth roads the forces are required to be as the angle of inclination, nearly; but when the wheels sink, they have to overcome the enlarged angle created by the cavity, in relation to the level ground which follows.

He has published a table, containing the results of experiments made upon *the hardness of road materials*, or their power of resisting the percussion of a given weight of cast-iron, falling a few inches upon the several specimens broken to the ordinary size, and resting upon stone or iron. Supposing the weather to have no action, the table would express nearly the relative value of the materials, for the purpose of supporting the wear of a road; and, therefore, those which resist the action of frost and weather, and have the highest numbers, are most valuable.

| | |
|---|---|
| Mount Sorrel sienite | 100 |
| White marble | 37·31 |
| Chert pebble, Middlesex | 34·27, 52·56, 55·65 |
| Quartz pebble | 70 |
| Ferruginous sandstone | 20·42 |
| Hurlock from lower chalk | 10 |
| Chalk | 3 |
| Granite, Scotch | 110 |
| Flint, yellow | 33·26 |
| Greenstone, Quittle Hill | 110 |
| Sandstone, soft | 13·6 |
| Tile fragment | 20 |
| Gritstone, near Brixworth | 48·60 |
| Limestone, near Bradwall | 5 |
| Dry clay | 12 |
| Flint, black | 11·30 |
| Portland stone, hard | 14 |
| Quartz, white | 56 |
| Blue pebble, like Rowley rag | 105·110 |
| Coarse limestone, near Stilton | 60 |
| Gritstone, near Leeds | 100·115 |
| Yorkshire paving-stone | 20 |
| Ketton, hard | 20 |
| Tetternhoe | 4 |
| Chert, from Devon and Cornwall | 57 |
| Gray wether, Herts and Wilts | 18 |
| Grit of upper bed, Collymeston | 40 |
| Second bed ditto | 100 |
| Slate at ditto | 50 |
| Stockton limestone, (lias) | 45 |
| Newbold, on Avon, ditto | 36 |
| Limestone of Stoke Cruerne | 35 |
| Copper slag | 243 |

The steady pressure, without percussion, required to crush a piece of the marble weighing half an oz. was 100 lbs.; to crush the grey flint of 1·2 oz. weight, 2000 lbs.; to crush the rolled white quartz pebble of 2 oz. weight, 3400 lbs.

Mr. Boase, of Regent's Park, has invented two machines. A *scraping-machine*, drawn by two horses, and attended by one man, will clean five miles of road, 24 feet wide, in eight hours; and two additional men will be required to throw the scrapings off the road, and clear the water-courses. The same work requires 25 men, with scrapers, according to the present method. The *sweeping machine*, with the same power and attendants, is capable of cleaning three miles, 20 feet wide, daily.

On 100 travelling miles, 100 horses cost 2500*l*. Wear and tear, and keep, per annum, 6000*l*. But steam-carriages cost 1500*l*. Wear and tear 300*l*. and fuel 6*d*. per mile. At two journeys per day 1800*l*. per annum, speed double. So that the saving is 4000*l*. per annum.

Oxen are employed, instead of horses, by farmers, in many districts. Their awkwardness and slowness create a prejudice against them, but many writers enlarge on their economy.

Paved roads require less draught than the best roads of gravel.

A road 10 yards wide covers an acre every 484 yards, of 12 yards wide an acre every 400 yards, and of 11 yards an acre every quarter of a mile. Hence the 60,000 miles of turnpike and bye-roads, in Great Britain, occupy 240,000 acres of land.

ROCHELLE SALT, is tartrate of potash and soda, 54 of the former and 46 of the latter. It is formed by dissolving 20 oz. of carbonate of soda in 10 wine pints of water, and adding, gradually, 20 oz. of cream of tartar, filtering the solution, evaporating it to a skin, and crystallizing.

ROCHE'S EMBROCATION, for the hooping-cough, is two olive-oil and one oils of amber and cloves.

ROD, in brick-work, is a superficies of 272 square feet, 1½ brick thick, and containing about 4500 bricks, and from 90 to 100 bushels of mortar. The cubic rod is 272 × 1·125 or 306 feet. It is 4 or 5 days work for the man and labourer.

Rod of Land, is the fourth of an acre of 1210 square yards, or nearly 35 yards each way.

ROLLERS, are most important implements for levelling and hardening roads and walks, and also for pressing the soil into contact with seeds, and the roots of grass. They are best made of cast-iron.

At Holkham there is a cast-iron roller of $3\frac{1}{2}$ tons, $5\frac{1}{2}$ feet in diameter. It is used to level grass fields, and the neighbouring roads. Spike-rollers are used to break up lumps in fields.

ROOM.—A well-formed room is 3 by 2, or 5 by 3, and from 9 to 14 feet high. It is generally finished with a dwarf wainscotting $3\frac{1}{2}$ or 4 feet from the floor, consists of skirting and moulding in the *base*—the dado, or flat pannel—and the sur-base, with its moulding. The side-frame of a sash is called the style, with a top, middle, and bottom railing. The frame of a door is called the style, the cross-pieces *rails*, and the central one the mounting, with pannels between.

ROOTS. As the extraction of square, cube, and other roots, and raising of powers, often occurs in arithmetical operations, every one ought to be aware that roots are most easily extracted, by simply dividing the logarithms of the number found in the tables, by 2 for the square-root, 3 for the cube, &c. and the resulting logarithm is the logarithm of the root, readily found in the same tables. So the powers are found by multiplying the logarithm of the number by 2, 3, &c. as it may be. This is important in annuities, and compound interest, where it is necessary to raise a rate of interest to the 20th, 30th, or 40th power.

*Roots of vegetables* are the parts that strike into the earth, when a seed begins to germinate, or the part emitted by the stem, for absorbing nutriment from the atmosphere; as in ivy, air-plants, vines, &c. It is distinguished from the stem by the absence of leaves. Such underground bodies as those called tuber in the potato; and bulb in the onion; are not roots. The office of the root is to absorb food in a fluid or gaseous state, by their young and newly-formed extremities, called *spongioles*, and, hence, the preservation of the spongioles is essential in the removal of a plant from one place to another.

But these organs have no power of selecting their food, but will absorb whatever the earth or air may contain, which is sufficiently fluid to pass through the sides of their tissue.

Roots when woody have, occasionally, the power of generating adventitious leaf-buds; and, when this is the case, they may be employed for multiplication. The exclusion of air from the roots always produces an unhealthy condition, or death; hence, light soil is indispensable to so many plants, and tenacious soil unsuitable to others.

Few people are aware, says Poynter, of the length and depth to which roots extend themselves. Tull's beautiful and simple triangle experiment proves the first, and the latter was proved by some gentlemen at Godalmin in Surrey, a few years ago, who filled with good soil a sugar-hogshead, four feet six inches in depth. Wheat was sown: and in the autumn, when the corn was ripe, the cask was carefully taken to pieces, and the tap-roots of the wheat were found to have extended to the very bottom of the cask, and the whole of the soil within the cask appeared to be full of the roots and fibres. I know a gentleman, who, for the instruction of his tenants and neighbours, repeats this experiment *every year*, in three different counties. The wheat need not be sown till February or March. The depth to which, in a loose soil, free from water and clay, roots of lucerne will in two or three years penetrate, is 7 or 8 feet. How is manure ever to reach to such a depth?

ROSE.—The rose has always been the favourite flower. In general, they are not delicate with respect to the nature of the soil, but flourish in almost every kind. Their easy culture has distributed them into almost every garden. The colour is, in different species and varieties, red, white, yellow, purple, or striped, either simple, or in all most numberless shades and mixtures; the flowers are single, semi-double, and double. Many hundred varieties are enumerated in the European catalogues, and new ones are produced annually: some of them are quite black. New varieties are obtained from seed, but the usual mode of propagation is by layers. For preserving delicate varieties, the best mode seems decidedly that of budding on hardier sorts. To produce strong flowers, requires some attention in pruning: old wood should be yearly cut out, and the young shoots thinned and shortened according to their strength, and whether number or magnitude of flowers be desired. Where very large roses are wanted, all the buds except that on the extreme point of each shoot should be pinched off as soon as they make their appearance, and the plant supplied with water.

The odour of roses is improved by planting a large onion so as to touch the root.

*Roses, compound infusion of.*—This excellent tonic is an infusion of the leaves of red roses, (which contain four grains in 1000 of iron) in dilute sulphuric acid, one fluid ounce containing 3-7ths of a minim of concentrated acid, or the 1100th in the officinal preparation, but, susceptible of any desirable increase.

*Rose-pearls, (or Rose-beads.)*—In an iron mortar beat red rose-leaves into a firm black paste, which roll into beads. Dry, and polish finely, and they are very hard and fragrant.

ROSEMARY.—The flowers are cephalic, nervine, cordial, heating, and strengthening. The infusion promotes the growth of the hair.

ROSIN, OR FRANKINCENSE, exudes from *pinus abies*, compact, opaque, and deep yellow. It is not so adhesive as Burgundy pitch, and sold for incense. *Native rosin* exudes from *pinus sylvestris*, the turpentine drying upon the wound, and forming a white crust over it. *White rosin* is prepared from native rosin, by melting and straining through a cloth. It is used, indifferently, as Burgundy pitch.

ROTATION OF CROPS, a law of nature, which assures perpetual abundance — a modern discovery, but one of the greatest. This law is one crop for beast, and one for man; or, one green crop and one white crop. Each promotes the other, and no exhaustion of the soil appears.

The rotation system converts old worn-out tillage into rich pastures, followed by fertile crops; or it converts worn-out pastures into productive tracts, and renews them within 7 or 8 years, in increased vigour. It requires labour and capital, and the ignorant mismanagement of our monetary system has, unhappily, for several years, deprived British farmers of the latter. Hence, a system so fraught with public and private advantage has been too generally arrested.

In *chalky soils*, paring and burning, with draining, may be followed by two crops of turnips, then barley, clover, wheat; and turnips, previous to the restoration by grass seeds, or saintfoin with some white clover.

On *peaty soil*, the same preparation, followed by rape, or potatoes, oats, turnips, wheat, clover, or grass seeds. Short courses are best.

On *loamy soils*, the succession, after mere deep ploughing, is oats, turnips, wheat or barley, beans, wheat, turnips, wheat or barley, with grass seeds.

On *sandy soils*, begin with carrots, mangel wurzel or beet, or, if very poor, with turnips, eaten on the ground; then barley and grass seeds.

In all cases, the green crops should be eaten on the ground, the straw converted into manure, returned, and lime or marl ploughed in. On wet soils, the crops should be drawn, or dry and poor ones eaten on the ground. Barley unites best with grasses, but oats on peat.

On *dry loams*, the rotation is turnips, or white peas, barley, clover, wheat, turnips, barley, and then grass for three or four seasons. Such land, by this rotation, is in good heart for ever.

In light soils, the rotation is turnips drilled; barley or wheat drilled; clover, and grass seeds, pastured with cattle, then sheep; lastly, oats. On strong land, fallow or beans is substituted for turnips.

Wheat on sandy soil best follows a clover ley.

In the Netherlands, the farmer obtains three crops:—1. corn, cut green. 2. Flax with carrots. 3. Turnips, spurry, or buck-wheat. The corn is sown in winter, and cut in May. The same are not sown two years in succession.

Flemish farmers sow carrots, turnips, and spurry, after a crop of wheat, with a slight ploughing. With oats they sow trefoil, or yellow clover, and cut that before they plough.

On this all-important subject, the Editor has trespassed on the public spirit of Sir John Sinclair, and extracted the following passages from his invaluable Code of Agriculture:—

The considerations which regulate the rotation of crops in every country are, *the Climate*, whether it be wet or dry, warm or cold; and the *situation*, whether high or low. *The soil*, for sand, gravel, clay, chalk, peat, alluvial soils, and loam, have various crops calculated for each respectively; and *the subsoil*, on the quality of which, the crops to be raised must greatly depend:—*The means of improvement by extra manure*, (as lime, marl, sea-weed, town-dung, &c.), at reasonable rates. *The state and condition of the soil;* whether it be old cultivated land, or recently improved; whether it be land that has been cropped judiciously, or under an exhausting system of management; whether it be in good heart, or the reverse; whether it be foul, or clean:—and, lastly,—the situation of the farm in regard *to markets*, whether they are near, or at a considerable distance; and whether they are adapted to the sale of some articles of produce more than others.

It is of the greatest importance to determine for what crops the soil and climate of any particular district are best calculated; and what objects may be obtained by their cultivation. In Great Britain wheat is, with the exception of potatoes, the principal *field crop;* whereas, in Flanders, it is considered as only the fifth in point of value, and it is often raised, merely as a means of procuring manure, for the more lucrative productions of flax, or hemp.

The crops usually raised on the different soils in Great Britain, at present, are as follow:

1. *Sand.*—Turnips, potatoes, carrots, mangel wurzel, barley, rye, buckwheat, tares, and oats in wet climates.

2. *Gravel.*—Pease, tares, rye, barley, (and on good gravels) wheat, oats.

3. *Clay.* Beans, wheat, oats, tares, cabbages.

4. *Chalk.*—Barley, pease, wheat, turnips, rape.

5. *Peat.*—Potatoes, carrots, tares, turnips, rape, rye, oats.

6. *Alluvial.*—Wheat, barley, oats, beans.

7. *Loam.*—Turnips, potatoes, carrots, mangel wurzel, barley, oats, wheat, pease, beans, tares, hemp, and flax.

And, on all these soils, clover and other grasses are, in a greater or less degree, cultivated.—*See* GRASSES.

*Three years' rotation*:—1. Swedish turnips; 2. barley; 3. clover. But the most productive course of cropping, for a period of three years, commencing with what may be called, under proper management, a cleansing crop, is 1. potatoes; 2. wheat; 3. clover. Potatoes, from eight to ten tons; wheat, about forty bushels; hay, four tons per acre.

*Four years' rotation.*—The Norfolk system: 1. turnips; 2. barley; 3. clover; 4. wheat. This rotation, however, is not found sufficiently meliorating; for, without a plentiful supply of extra manure and deep ploughing, both the turnip and the clover crop will often fail, unless the land is refreshed by grass, for at least two or three years. To obviate this difficulty, it has been proposed to begin with, 1. Winter tares, followed by turnips, and both fed upon the land by sheep. The soil, thus enriched, will produce, 2. wheat; 3. clover; and 4. barley, or oats.

In Scotland, on turnip soils, the following rotation has been found to answer: 1. turnips; 2. winter wheat, sown in spring, or barley; 3. clover; and, 4. oats, introducing partly winter wheat after the turnips, and oats after the clover. This is a productive rotation.

Under careful management, a rotation still more severe has succeeded; namely, 1. turnips; 2. wheat; 3. grass, (mostly sheep-fed): 4. four-fifths winter-wheat sown in spring, and one-fifth oats. Under this course of crops, the produce of a farm has been improved, both in quality and in quantity.

The rotation of four crops, adopted near Edinburgh, namely, 1. potatoes; 2. wheat; 3. clover; and, 4. oats, is a very productive one, but is only calculated for the neighbourhood of great towns, where there is an ample command of manure, of a superior quality, and a demand for potatoes.

*Five years' rotation.*—Rotations *of five crops* have in many cases been recommended, both for strong and light lands: 1. potatoes; 2. wheat; 3. grass; 4. pasture; 5. oats. In this course, there were only two crops of corn to three of green crops, and it is a safe maxim, that grain should only be sown when the ground is laid down to grass, or ploughed from it.

Upon mossy or peaty soils, after effectual draining, the following course is recommended: 1. Potatoes; 2. Rye; 3. Clover; 4. Pasture; and, 5. Oats, or barley. Peaty soils are apt to get puffy by tillage, and require, in general, pasture to consolidate them.

The following course of crops is often preferred: 1. A cleansing crop, of whatever kind, as best suited to the soil, as turnips, tares, or cole-seed, to be hoed, but not to stand for seed; 2. A crop of white corn, of the kind best suited to the soil, to be laid down with seeds; 3. Clover, either grazed or mown; 4. Beans, where suited to the soil, to be sheep-fed and hoed, or some other meliorating crop adapted to the soil; 5. White corn suited to the soil.

By such a system of cropping, a soil of tolerable natural richness might not only be supported without foreign aid, but might increase in fertility. A certain degree of richness, however, is sufficient to produce maximum crops of grain. Land may be too rich, as well as too poor, for growing corn.

*Six Years' Rotation.*—Rotation of six crops *are peculiarly calculated for large farms.* This species of rotation may be considered under the three great divisions of, 1. Clay lands; 2. Sandy lands; and, 3. Loams.

1. *Clay lands.*—On wet or adhesive lands, which have been long in cultivation, a fallow, and, in some cases, a fallow-crop, once in six years, are strongly recommended; the favourite rotation being, 1. Fallow, winter tares, Swedish turnip, or cabbages; 2, Wheat; 3. Clover; 4. Oats; 5. Beans; 6. Wheat. In Suffolk, the years for producing the clover and the beans are reversed. But clover near the fallow.

2. *Sandy Lands.*—A rotation of six may also be adopted in sandy soils; as 1. Carrots, tares, turnips, or potatoes; 2. Barley, or oats, with seeds; 3. Hay, or soiling; 4. Pasture; 5. Pasture; 6. Oats. Under that course such soils become highly productive, and, instead of being exhausted, improve in fertility.

3. *Loams.*—On this species of soil the following plan is recommended; 1. Turnips, or fallow; 2. Wheat, or barley; 3. Seeds, either clover alone, or clover and rye-grass, with the addition of a little yellow or hop clover; 4. Oats; 5. Tares, pease, or beans; 6. Wheat. Rich loams, adapted to this productive rotation, will pay the highest rent of any, more especially when early oats are sown after clover; for invariably, on all friable soils, that grain is the most beneficial of crops, seldom producing less than 60 bushels per acre, and much more profitable than wheat.

*Seven Years' Rotation.*--The following rotation is adopted in rich deep soils:

1. Turnips; 2. Barley; 3. Beans; 4. Wheat; 5. Barley; 6. Clover; 7. Wheat. Under that system, the crops are productive; the land clean; with the neatest possible appearance.

*Eight Years' Rotation.*—Upon rich loams and clays, or where there is abundance of manure at command, a course of eight crops has been strongly recommended: 1. Fallow, with dung; 2. Wheat; 3. Beans, drilled and horse-hoed; 4. Barley; 5. Clover and rye-grass; 6. Oats, or wheat; 7. Beans, drilled and horse-hoed; and, 8. Wheat, or oats. This rotation is calculated to insure an abundant return throughout the whole period, provided dung be given to the clover stubble.—*See* FARMING *and* GRASSES.

ROUGE. Take petals of safflower; wash till the water is colorless, dry, then infuse in ley of sub-carbonate of soda; pour the yellow liquid on fine carded cotton, and add acetic or citric-acid, or lemon-juice, and the cotton will be yellow-red; wash out the yellow tinge, again infuse in fresh soda ley, decant upon some fine French chalk-powder; by the acid, precipitate the pure red matter, and in olive-oil grind the colored chalk.

RUDDER, is the lever which guides a ship by the action of the stream upon it, by which the course is varied. It consists of two or more pieces of timber, of the thickness of the sternpost, of which, when not inclined, it seems a continuation. Narrow at the water's edge, where it might be endangered by the shock of a sea, and with it the very existence of the ship, it gradually increases in width towards the keel, where, from the nearly straight line in which the water reaches it, it exerts a more direct power to turn the ship. From forty to forty-five degrees is the most favourable angle for it to make with the keel, a greater serving rather to retard velocity than to cause rotation. To ship the rudder, it is only necessary to attach weights of iron to the heel, so that they may be loosed afterwards, and then sink it behind the sternpost, guiding it with ropes to the rudder port, through which it is hoisted by means of sheers and tackle placed above. The pintals having caught the hinges, or gudgeons, on the sternpost, it is abandoned to their support, while a choak, placed above the upper pintal, prevents it from being unhung. A tiller, with ropes and a wheel, to turn the rudder, completes the steering apparatus. The main piece and the bearding piece are always oak, and the rest generally fir. The rudder should be bearded from the side of the pintles, and the fore-side made to the form of the pintles: but when they are bearded to a sharp edge at the middle line, which is the customary way, it reduces the main-piece more than is necessary, which is easily perceived in large ships, for, when the rudder is hard over, the bearding will not be close to the stern-post by nearly three-quarters of an inch. The *Rudder-irons*, or *Pintles*, are the irons which are fastened to the rudder, in order to hang it up to the stern-post, and sometimes there are two of them cut short to work in a socket in the brace, which makes the rudder work easier.

The New York Nautical Institution lately came to a formal resolution that no improvement can be made in the construction of ships' rudders, and that long tillers are preferable to short ones.

RUM, is made from diluted Molasses, to 10° or 12° of density, or about 1080 of Beaumé. Heat of climate renders no leaven necessary, but the fermentation is slow, 10 or 12 days, and the product weak. The spent wort, after the first distillation, is used for the next fermentation, which it promotes. The taste, on leaving the worm, is acrid, but it improves by keeping.

*Rum-shrub.*—In 9 pints of Rum infuse the peels of 4 oranges and 2 lemons, with 2 pounds of sugar, and add 1 pint of lemon, and also of orange-juice, and 5 pints of water.—*Or*, in 4 gallons of raisin-wine, and 5 of water, and 10 gallons of rum, mix 8 ounces of citric-acid, 4 pints of honey-water, and 6 pounds of honey.—*Or*, in 8 pints of rum mix 24 ounces of sugar, and 2 pints of orange-juice.

RUNNET, or VELLS, are the stomach of calves, used in cheese-making for curdling the milk, though some herbs and acids equally effect the same purpose. Irish Vells are preferred, and they are prepared for use when 12 months old, by adding to every 6 vells 2 gallons of brine, and 2 lemons, and letting it stand 2 months.

RUSHES, (*Junceæ*,) are the common soft rush. Astringent.—the sweet flag,. a sweet-scented agreeable stomachic, which might be used for the foreign spices; dose from 1 scr. to 1 dr.; used, also, to flavour Prussian rye spirit and French snuff. The green root is candied.

*Dutch rushes*, of which the epidermis is formed of silica, are used to polish wood and metals.

RUSPINI'S TINCTURE FOR THE TEETH, is made from 8 oz. of Florentino Iris; 1 oz. of cloves; 1 scru. of ambergris; and 2 pints of rectified spirits.—*Paris.*

RUST. The following composition is said to be an effectual preservative of iron from rust. One oz. of jet, ground to the finest powder; 4 oz. of vitriol of lead, and 1 oz. of white vitriol, mixed in a pound of linseed-oil varnish, and stirred carefully over a slow-fire till the mixture attains a boiling state.

RYE, is the seed of *secale cereale*, a plant cultivated in the northern parts of Europe as an article of food. Bread made of it is much denser than wheaten bread, and has a brownish colour, with a peculiar sweetish taste, which to most persons is rather agreeable.

Of good rye-seeds 3840 parts are composed of

| | |
|---|---|
| Husk . . . | 934 |
| Moisture . . | 390 |
| Pure meal . | 2520 |
| | 3840 |

The same quantity of good rye-meal contained

| | |
|---|---|
| Albumen . . | 126 |
| Gluten, not dried . | 364 |
| Mucilage . . | 426 |
| Starch . . . | 2345 |
| Saccharine matter . | 126 |
| Husk . . . | 245 |
| Loss . . . | 208 |
| | 3840 |

RYMER'S CARDIAC TINCTURE. In a pint of alcohol infuse 2 drs. each of capsicum, camphire, rheubarb, aloes, lesser cardamoms, and castor; and 20 drops of sulphuric acid.

SACLACTIC ACID, is formed by treating gum, or sugar of milk, with nitric acid.

SAFETY-LAMP. This is a very simple contrivance, depending on the power of metals to conduct heat, and so much of it, that the remainder will not sustain or constitute flame. Every one is aware of the power of a single pin to extinguish a rush-light, by carrying off such portion of its heat as is necessary to the support of the flame. Sir H. Davy, then, surrounded a lamp with wire-gauze, which permitted the light to pass through its meshes, while the meshes prevent the flame of hydrogen gas from passing and exploding the volume on the outside. The wire-gauze is so fine, that there are from 600 to 800 meshes to the square inch, and the wires, by conducting the heat, prevent the generation of flame on the outside. The inside is filled with flame, when the hydrogen is 1-5th or 1-6th of the atmosphere, and at 1-3d, the men can no longer work. Red-hot wire, or sparks, produce no explosion of hydrogen; and, hence, steel mills, for generating sparks, are often used for light in mines. Flame alone produces explosion, and this cannot, for the cause assigned, pass through the wire meshes.

Others have been proposed, as one by Dr. Clanny, of Newcastle, and, we believe, with complete success.

Mr. Dillon has lately introduced an improvement upon it. He maintains that the lamp acts by its heat and rarefaction, and not on Davy's theory, that flame is cooled by the wire-gauze covering. He shows that the Davy lamp is not safe in a current of hydrogen or carburetted hydrogen gas. A current of hydrogen, or carburetted hydrogen gas, steadily directed on the flame of the lamp, from a bladder and stopcock, *by cooling the wire-gauze*, brings the flame of the lamp through the gauze to the mouth of the stop-cock, even should there be six folds of gauze intervening. He shows, also, by immersing the lamp, when cold and newly lighted, into a jar of dense hydrogen, or carburetted hydrogen gas, or an explosive mixture with atmospheric air, that explosion takes place inside and outside of the lamp; whereas, when the lamp has burnt sufficiently long to heat the wire gauze, no explosion takes place on the outside of the lamp. His theory is, "*that the wire-gauze is merely the rapid receiver and the retainer of heat, and that it is the heat in its meshes which prevents the flame of the lamp from being fed by the oxygen of the atmosphere on the outside.*"

The experiments of Libri, showing that flame is inflected by metallic rods, and that, when two flames are made to approach each other, there is a mutual re-action, although their proximity increases the temperature of each, instead of diminishing it, support Dillon's theory. Mr. Dillon, therefore, increases the heat of the lamp, and places on it a shield of talc to protect it from a current; and, upon his theory, the shafts, or workings of iron and coal mines may be lighted with gas with perfect safety.

Mr. ROBERTS has adapted reflecters to increase the light of the Safety Lamp, an effect so desirable.

SAFFLOWER, *or* CARTHAMUS.—Watery menstrua take up only the yellow, and leave the red, which may afterwards be extracted by alcohol, or by a weak solution of alkali. This, after the yellow matter has been extracted by water, gives a tincture to ley, from which, on standing at rest for some time, a deep red secula subsides, called safflower. This pigment impregnates alcohol with a beautiful red tincture, but communicates no colour to water.—*See* ROUGE.

Carthamus is used for dyeing silk of a poppy, cherry, rose, or bright orange-red. After the yellow matter is extracted, the cakes are put into a deal trough, and sprinkled at different times with soda, well powdered and sifted, in the proportion of six pounds to a hundred, mixing the alkali with carbonic acid. The carthamus is then put on a cloth, in a trough with a grated bottom, placed on a larger trough, and cold water poured on. And this is repeated, with the addition of little more alkali, till the red is exhausted. Lemon-juice is then poured into the bath, till it is turned of a fine cherry color, and, after it is well stirred, the silk is immersed in it. The silk is wrung, drained, and passed through fresh baths, washing and drying after every operation; when it is brightened in hot-water and lemon-juice. For a poppy or fire colour, a slight annotta ground is first given; but the silk should not be alumed. For a pale carnation, a little soap should be put into the bath.—*Nicholson.*

SAFFRON, *(Crocus,)* is a plant cultivated near Glazenwood, in Cambridgeshire, and at Saffron Walden. Parts of the early flowers are dried, and formed into cakes, or sold loose. Distilled with water it yields oil. In doses of 10 grs. to half a dr. it is anti-spasmodic, and stimulating, and with this design is slightly infused in the water of birds.

SAGE TEA, is considered an excellent remedy in cases of debility of the stomach, or morbid sensibility, or relaxation of the nervous system. There are above seventy sorts of sage—and, perhaps, it is owing to our not using the same sorts, that the virtues of sage are less appreciated in modern times. Three sorts are used:—1, the Garden Sage; 2, the Red Sage; and 3, the Wood Sage.

SAGO, is prepared from the pith of the Cicas Circinalis, and its granulated form arises from its being passed, while moist, through a sieve.—*Paris.*

SAILS. The sails of a ship are square sails, bent to the yards, and fore and aft sails, traversing on stays or bent to gaffs. On the extremity of the bowsprit is the flying-jib, a three-cornered sail, which goes from the end of its boom upward, along its stay, leading to the fore-top-gallant-mast-head, and confined to the stay by rings of wood or iron, called *hanks.* It is hoisted by means of halyards, hauled down by a downhaul; and, when up, is trimmed to hold the wind by a sheet leading to the forecastle. The jib, which leads from its boom to the fore-top-mast-head, is of similar form, and so is the fore-top-mast-stay-sail, running from the bowsprit end towards the mast-head. On the fore-mast we have the fore-sail, bent to the fore-yard, and spread at the foot by means of tacks and sheets; above it, the fore-top-sail, bent to the top-sail-yard, by means of which it is hoisted aloft, while its lower corners are spread to the extremities of the fore-yard; next the top-gallant-sail, bent to its yard, and sheeting home to the top-sail-yard; and so with the royal and sky-sail. All these sails are turned at pleasure, to be presented to the wind, by means of braces attached to their yard-arm, and leading to the main-mast. The main-mast is furnished with a similar suit of sails, somewhat larger; the mizen, also, though smaller than either, instead of a square-sail on the lower mast, it has a gaff-sail, hoisting up and down abaft the mast. Some ships have similar gaff-sails on the fore and main-masts, which are found of great use in gales of wind, as a substitute for storm stay-sails. Most carry, also, light stay-sails between the masts; but they are very troublesome, and worse than useless. Studding-sails, or *wings*, as they are better called by the Spaniards, spread without the square-sails, when going large, and are very useful. The perfection of equipping a ship with spars, rigging, and sails, consists in so disposing them, that, in a whole-sail breeze, the centre of effort of all the sails will be in the same line with the ship's centre of rotation.

SALAD, Spring.—Great quantities of the blanched leaves of chiccory are sold in the markets in the Netherlands, early in the spring, and supply salads long before lettuces. The roots, which are of the shape and size of a carrot, and are extensively employed, when dried, as a substitute for coffee, are taken up in autumn, and placed in a bed, almost as closely as they can stand together, with merely a little earth to fill up the vacuities.

SALEP POWDER, *(French Salep,)* is potatoes, peeled, cut in slices, and baked until brittle, horn-like, and breaking like glass; then ground to a whitish powder.

SALIVA.—The fluid secreted in the mouth, which flows in considerable quantity during a repast, is known by the name of saliva. It is a limpid fluid, like water, but much more viscid; and has neither smell nor taste. Its sp. gr. is 1·0167. When agitated, it froths, like all other adhesive liquids. It mixes readily neither with water nor with oil; but it has a great affinity for oxygen, absorbs it readily from the air, and gives it out again to other bodies. Hence the reason why gold or silver, triturated with saliva in a mortar, is oxidized; and why the killing of mercury, by oils, is much facilitated by spitting into the mixture; for mercury soon disappears when triturated with saliva.

When saliva is evaporated it swells exceedingly, and leaves behind it a from that which yields salt or soda; and, indeed, one village, or one street, frequently contains the three salts.

The most profitable way of preparing it is, to evaporate it in shallow basins of mortar. The earth is swept up every other day, and contains about one-fifth of crude saltpetre. After the saltpetre is extracted, the earth is heaped-up till the rains are over, and then spread out, and in a year or two it yields again.

About two gallons of saltpetre-earth is collected at the foot of each yard of wall. The saltpetre gained from black cotton ground contains more common salt than that from common earth. The pans of mortar are filled about four inches deep, about half is evaporated in four or six days, and the saltpetre begins to crystallize. The first day's product is the purest; the second day's contains about half common salt: the third day's contains scarcely a quarter of saltpetre.

Saltpetre is refined by boiling; adding soap, milk, eggs, and twigs of euphorbia tirucalli: and single-refined saltpetre still contains about a quarter of common salt. Bengal saltpetre is browner than that of the coast.

If saltpetre is kept or prepared in any apartment, it is difficult, in India, to prevent the destruction of the walls, by the continual production of the salt.

Calcareous earths, impregnated with saltpetre, are found in caverns in limestone, in various places. The saltpetre-earth of Georgia, United States, contains both the nitrate of potash and that of lime; but the latter is changed into saltpetre, by adding wood-ashes; one bushel of earth yields from three to ten pounds of saltpetre. Kentucky saltpetre-earth is similar; it is washed, and the ley passed through wood-ashes, when a bushel yields from one to two pounds of saltpetre.

Similar earths are found at Molfetta, Naples, Hungary, and various places.

Kentucky rock-ore is a sand-stone, which, when broken to fragments, and thrown into boiling-water, soon falls into sand; and the liquor strained from it yields, by crystallization, from ten to twenty pounds of nitre from each bushel of stone. This nitre contains little or no nitrate of lime, and is considered better for gunpowder than that obtained from Kentucky nitre-earth. Masses of saltpetre, of several pounds weight, are sometimes found in the fissures of this sand-stone, accompanied by masses of a black bituminous substance. Similar sand-stones are found in South Africa.

The saltpetre formerly used in England was extracted from the mortar of old buildings, as it still is in France and Prussia. The mark, by which saltpetre-workers know good mortar for their purpose is, that it tastes acrid and salt, when applied to the tongue; but to this it may be also added, that it ought to be of a greyish colour, and such as, when powdered and sprinkled upon burning charcoal, yields sparks; and, the more sparks it gives, the better it is for the purpose. Another characteristic is, that these well-impregnated mortars have a certain unctuosity or fattiness to the touch, which other kinds have not.

The best of all kinds of mortar, for saltpetre-work, is such as is had from the ruins of old buildings in a low situation, and out of the way of much sunshine, where there has been no great quantity of fire kept, and especially such as has served for the mortar of the walls of stables. In Prussia, the rubbish of old buildings is built up in thin long walls, sheltered from the weather by straw coverings, and sprinkled with urine of all kinds, for the purpose of generating this salt.

A clear dry frosty air is particularly favourable to the production of saltpetre, and it disappears in snow-storms.

Napier detected impurities in nitre, by dropping a strong solution of sugar of lead into a phial of distilled water, saturated with saltpetre; if it retained any considerable portion of marine-salt or magnesia, it assumed a turbid milky appearance. The best is Russian; yet the manufacturers seldom refine their nitre more than twice; and it has been found that their saltpetre contains a considerable portion of marine-salt and magnesia. There is reason to believe that powder, made with saltpetre oftener than four times refined, is of inferior strength.

The goodness of saltpetre is measured by the angle at which light is refracted in passing through it. As the angle is less, the quality is better. This angle varies very considerably. An angle of 5° is called par, and, the variations from it are made up by increasing or diminishing, not the price, but the quantity; for every degree by which its angle of refraction exceeds 5, 1 per cent. in weight is allowed, and the contrary. It is tested at Apothecaries' Hall, and the several refractions, denoting the quality, are marked upon the bags.

SANDAL-TREE, *(sirium myrtifolium.)*—The outside of the wood is *white sanders*, and the heart *yellow sanders*. It is aromatic, slightly bitter, and sweetish, cordial, and cephalic.

SAND.—Sand is an assemblage of small stones. Its chief uses are in compositions for pottery and glass, and some sands are more and some less fusible, according to the various stones from which they may have originated. The size of the particles is of importance in these works. It is the wearing down of rocks by attrition, during the sub-marine state, or the advance and retreat of the ocean.

Sand drifts, or floods, are arrested by planting marum, or sea-bent, or the arundo arenania, and other plants, that take root in sand.

Sandstone is, in most cases, composed chiefly of fine grains of quartz united by a cement, which is nearly or quite invisible. The cement is variable, and may be calcareous or marly, argillaceous, or argillo-ferruginous, or even silicious. When silicious, sandstone resembles quartz. Some varieties are so hard as to give fire with steel, while others are friable, and may be reduced to powder by the fingers. Some have a slaty structure, arising from scattered and insulated plates of mica, and are often called sandstone slate. Some sandstones contain grains of feldspar, flint, and silicious slate or plates of mica. The mica is in considerable quantities in those friable sandstones which accompany coal. Some are so ferruginous as to form a valuable ore of iron, containing either an oxide or the carbonate of iron. Red sandstone is sometimes connected with coal. In the older formation it sometimes contains metallic substances disseminated through the mass, or in beds or veins. Various organic remains occur in sandstone, among which are reeds, impressions of leaves, trunks of trees, and shells, both fluviatile and marine. In some of its varieties it is often known by the name of freestone, and is employed as a building-stone. In most cases, it may be cut equally well in all directions; but some varieties naturally divide into prismatic masses. Some compounds are used as mill-stones. When porous, it is employed for filtering water. Some are even used for whetstones.

SAP OF VEGETABLES.—Whatever tends to harden sap, as a dry and heated atmosphere, or an interruption of its rapid flow, or a decomposition of carbonic acid, by full exposure to light, has the property of causing excessive vigour to be diminished, and flower-buds to be produced. On the other hand, whatever tends to dilute the sap, as a damp atmosphere, a free circulation, or a great accumulation of oxygen in consequence of the imperfect decomposition of carbonic acid, causes rapid growth, and an exclusive production of leaf-buds. Inspissated or accumulated sap is, therefore, a great cause of fertility. And thin fluid is a great cause of sterility.

SAP GREEN.—To 8 pints of lime-water and 6 oz. of gum arabic add 12 pints of juice of evergeen privet, black alder, or buckthorn berries. Mix well, then evaporate to about half, and pour into strong bladders.

SAROCOLL, a gum, sold in globules, smelling like aniseed. It yields oxalic acid, and its variety liquorice; in nitric acid it is tannin.

SASSAFRAS, is a laurel which grows here, but for medical purpose in the West Indies and America. The wood, root, and oil, are employed, and the chips are drank as tea for rheumatism, gout, &c., and it operates as a diuretic and diaphoretic very beneficially.

SATIN; a soft closely-woven silk, with a glossy surface. In the manufacture of other silken stuffs, each half of the warp is raised alternately; but, in weaving satin, the workman only raises the fifth or the eighth part of the warp; thus the woof is hidden beneath the warp, which, presenting an even, close, and smooth surface, is capable of reflecting the rays of light. In this way satin acquires that lustre and brilliancy which distinguish it from most other kinds of silks.

SATURATION.—Some substances cannot be dissolved in a fluid, at a settled temperature, in any quantity beyond a certain proportion. Thus, water will dissolve only about one-fourth of its weight of common salt, and, if more be added, it will remain solid. But saturation with one substance does not deprive the fluid of its power of acting on and dissolving some other bodies, and, in many cases, it increases this power. For example, water, saturated with salt, will dissolve sugar; and water saturated with carbonic acid will dissolve iron. If we mix together and agitate good ether with water, a part of the ether unites with the water, nearly in the proportion of one to 10; so that, if one part of ether be added to ten parts of water, all the ether disappears, by being diffused through the water. If the quantity of ether be more than one-tenth part of the water, the overplus will float distinct upon the surface, like oil.

Alcohol can dissolve only a determinate quantity of each kind of essential oil, which quantity varies, according to the kind of oil, and to the state in which it happens to be. Water is the proper solvent of neutral salts. It is capable of dissolving any of them, but most of them only in a certain quantity; and this point of saturation is most distinct with those salts which contain a small quantity only of the water of crystallization, and which are nearly equally soluble in hot and in cold water.

When the water is saturated, the strongest and longest boiling does not dissolve a grain more, and the overplus of the salt remains entire at the bottom of the boiling water; but boiling water dissolves an equal, or even an unlimited quantity of some salts, chiefly of those which contain much water in their crystallization, such as sulphate of soda, alum, borax, sulphates of iron and copper, and others of that kind. The water of crystallization of these salts is alone sufficient to keep them dissolved, by means of heat. Hence, when they are exposed to fire, without water, they suffer a liquefaction, which is very different from fusion.

When greater heat than that of boiling water is wanted in fluid, a saturation with alum does not boil till 220; with common salt, not till 224; with nitre till 238; nor with Rochelle salt till 240. Mercury may be used up to 600°, or a mixture of 8 bismuth, 5 lead, and 3 tin, which melts at 212, and will then bear a white heat. Tin is fluid at 441, and lead at 609. In testing the heat, the thermometer should be open when above 580°, for it then boils in the tube.

SAVINE, or JUNIPER, LEAVES, are much used in medicine, for female complaints. Water or alcohol extracts their virtue; or, by distillation, they afford essential oil. They are very acrid, and used in ointments for languid ulcers. The berries, distilled as oil, are used in flavouring hollands, and are an article of large commerce.

SAWS, are wedges to tear their way through an obstacle. They are reciprocating or circular. The former are well known as hand-saws, or reciprocating ones, such as are seen in saw-pits. The circular, as better adapted to power, and more precise and rapid in their action, are becoming general. They were invented in Holland, about 1780, and are a great acquisition. The machine which turns the saw draws the piece to the work, which is so accurate that an inch thick of certain woods may be divided into 20 uniform sheets, allowing for waste.

SCALES, are measures of the downward tendency, centripetal force, or weight of bodies. A body is put in one scale, whose weight is known, and the arms being truly equal, a body of unknown weight balances the known weight. When well made, they are true to the 50000th of the body weighed; but the friction of large scales renders it ineligible to weigh ounces or grains in them; since the friction on a hundred weight is the third of an oz.

SCAMMONY, (*convolvolus*,) is the product of the root of a plant which flourishes in Asia Minor. The medicine is the inspissated juice of the root. It is best dissolved in proof spirit. It is a powerful and quick purge, and very efficacious in expelling worms and slime. The dose is from 5 to 16 grs.; and, to prevent griping, it may be combined with ginger, coriander, or an essential oil. Another species of convolvolus is jalap.

*Compound Scammony Powder.*—Mix 2 oz. of scammony, and of extract of jalap, with half an oz. of ginger. Dose 8 to 15 grs.

SCARIFIER, or GRUBBER, is an implement often used instead of the plough. It clears off weeds, and breaks up the surface sufficiently for many purposes, especially the mixing of manures with the soil. It is equal, in utility, to the plough, harrow, and roller.

SCHOOLMEN, those who teach by precedent and obsolete authority, instead of thinking for themselves and adopting the latest improvements in practice and theory. Locke waged war on these team-horses of science. A person is promoted by a committee or council to teach the dogmas of the committee, which are those of some remote epoch; and if he were to follow his own convictions, and adopt any novelties, he would be forthwith superceded. Those who elect and controul them, and those who yield to such controul, are called schoolmen; because they are such persons as commonly fill the chairs of universities and endowed seminaries.

SCIONS, are cuttings, which grow upon another plant, and not in the earth. When a scion is adapted to another plant, it absorbs fluid from it, for the nourishment of its leaf-buds, until they can feed themselves. Its buds gradually grow upwards into branches, and send woody matter downwards, which is analogous to roots. At the same time the cellular substance of the scion and its stock adheres, so as to form a complete organic union. The woody matter, descending from the buds, passes through the cellular substance into the stock, where it occupies the same situation as would have been occupied by woody matter, supplied by buds belonging to the stock itself. Once united, the scion covers the wood of the stock with new wood, and causes the production of new roots.

SCOTCH MARMALADE.—Boil together, 3 hours, 2 pints of Seville orange-juice; shred the orange-peel, and add 2 lbs. of yellow honey.

But always, in using honey, prefer that which is taken without destroying the industrious and ingenious collectors of it, by the use of *Nutt's Collateral Hives*. This ingenious person has contrived to make a triple hive, the side ones of which may be reserved by cooling them, and driving the bees into the central hive. He then interposes a thin partition, and each side yields 35 or 40 lbs. of honey. Then, by replacing it, the stock is increased with wonderful profit. An upper hive, above the central one, is also soon filled by the fugitives from the sides, and a triple quantity obtained by like means.

SCOTS' PILLS, are made of Barbadoes aloes, with jalap, and oil of aniseed, exposed to moderate heat, and stirred till of proper consistence.

SCROFULA, a disease of fair children, consisting of hard tumours of the glands, particularly in the neck, which, after a time, suppurate, and degenerate into ulcers, from which white curdled matter is discharged. It seems to be peculiar to cold and variable climates, being rarely met with in warm ones.

The first appearance of the disorder is commonly in that of small oval or spherical tumours under the skin, unattended by any pain or discolouration. After some time, the tumours become larger and more fixed, the skin which covers them acquires a purple or livid colour, and, being much inflamed, they at last suppurate, and break into little holes, from which, at first, a matter somewhat puriform oozes out; but this changes, by degrees, into a kind of viscid serous discharge, much intermixed with small pieces of a white substance. In this manner the disease goes on for some years; and, appearing at last to have exhausted itself, all the ulcers heal up, without being succeeded by any fresh swellings, but leaving behind them an ugly puckering of the skin, and a scar of considerable extent. The treatment is warm sea-bathing, country air, exercise, and nourishing diet, with calomel; but, if neglected, it affects the diaphragm and often ends fatally.

SCOURING BALLS. *(For grease-spots in clothes.)*—Mix 8 oz. of white soap, 1 oz. of oil of turpentine, 2 oz. of ox-gall, and 1 dr. of lemon-juice, and 8 oz. of starch-powder.

To take grease-spots out of paper, apply the powder of burnt bones above and below, and subject it to pressure for two or three days.

SCREW-CUTTING.—Those who are possessed of a lathe with a slide-rest to it, which is now in very frequent use, may convert the screw of that rest into a pattern screw, whereby to cut original right and left threaded screws of various rakes and diameters, in the following simple manner:—The screw of the slide-rest has generally a square formed at one end of it, to fit a winch or handle upon, in order to turn the screw, and urge the turning tool forward. Now, it will be necessary to have another square, also, formed at the opposite end of the screw, upon which a square socket can be secured by a binding-screw; this socket is united with one of the forks of Hooke's universal joint, formed of two such forks, with screws, passing through the ends of the forks, having conical points to them, which enter into four holes, made around an iron ball or sphere, at equal distances apart; the two forks being thus affixed to the ball, at right angles to each other, and as usual in forming this kind of universal joint. The stem of this second fork is elongated, and has a neck or pivot, made near its other end, which works in a cleft pivot-hole, formed in a standard, which is affixed on the top of a cylindrical stem, which can be fitted into the socket of the ordinary lathe-rest, and bound by its screw as usual. Upon the exterior end of the stem, beyond the neck or pivot, toothed wheels or pinions, as the case may require, must be fitted, and bound tight by a screw and nut; and into or upon the nose of the lathe-mandrel, a chuck must be screwed, which can, likewise, have other toothed wheels or pinions affixed upon it, next or adjoining to the mandrel, to work into the first-mentioned toothed wheels or pinions. The front end of the chuck must also have a square hole made in it, to receive into it the squared end of the steel cylinder, which is to have the screw cut upon it; and the other end of which cylinder is to be supported by the back centre of the lathe as usual.

A properly-shaped turning-tool is then to be placed and screwed fast in the socket of the slide of the slide-rest, and be brought to act upon the steel cylinder, which is to be cut into the screw in the usual manner of turning; and, by the disparity in the proportions of the toothed wheel-work, the turning tool will be carried along faster or slower, so either as to cut coarser or finer-threaded screws than the original one, or a similar one, though of a different diameter, if the toothed wheels be equal. The universal joint here is necessary, to accommodate the change of motion from a right line to any angle less than a right angle. Should left-hand threaded screws be required, an intermediate wheel or pinion, to reverse the motion, must be affixed to the standard, and be brought to act in the other wheels or pinions.

The following is a simple and economical method of cutting original screws: You must leave the piece of steel, from which you intend to form your tap, a little longer than necessary, and having turned it true throughout, at one end turn down, somewhat lower than the rest, a neck or space about half an inch in length; round this space coil a piece of wire, and you will, at once, be in possession of a primary artificial guide, which will regulate the pitch of your intended screw. You have now nothing to do but to make your tracing-tool to the spiral groove formed by the wire, and begin tracing your thread. By this simple method you may obtain, by varying the thickness of your wire, a screw of any required pitch, either right hand or left.

SCRUPLE, is 20 grs., of which a ℔. is 5760 grs., so that it is the 288th of a ℔. It is abbreviated in this character ℈.

SCULPTURE.—Before any object is executed in stone, sculptors complete a representation of their design by modelling it in clay. The genius of the artist is displayed altogether in the model; for the process of copying the model in stone is chiefly mechanical, and may be executed by another person, as well as by the sculptor himself.

When a clay model is taken, and the proposed figure be large, a frame of wood or iron is erected, to give support to the limbs, and different parts of the figure. Upon this frame a proper quantity of wet clay is distributed, and wrought into the form of the intended statue. To execute a statue in marble, which shall exactly correspond to a pattern or model, is mechanical, and performed by finding in the block of marble, the exact situation of numerous points, corresponding to the chief elevations and cavities in the figure, and joining these by proper curves and surfaces. These points are found by measuring the height, depth, and lateral deviation of the corresponding points in the model; after which, those in the block are found by similar measurements.

Sometimes the points are ascertained by placing the model horizontally under a frame, and suspending a plumb-line successively, from different parts of the frame till it reaches the parts of the figure beneath it; or, an instrument is used, consisting of a moving point, attached by various joints to an upright post, so that it may be carried to any part of the statue, and indicate the relative position of that part in regard to the post. Machines have also been contrived for cutting any required figure from a block, the cutting instrument being directed by a gauge, which rests upon the model in another part of the machine. Marble is wrought to the rough outline of the statue by the chisel and hammer, aided by the occasional use of drills and other perforating tools. It is then smoothed with rasps and files, and, when required, is polished with pumice-stone and putty. Some of the most celebrated antique statues, such as the Laocoön, the Apollo Belvedere, and Venus de' Medici, are thought to have been finished with the chisel alone.

Statues intended to occupy exposed situations are commonly made of bronze. Moulds are made on the pattern, out of plaster and brick-dust. The parts of this mould are covered on their inside with a coating of clay, as thick as the bronze is intended to be. The mould is then closed, and filled on its inside with a nucleus or core of plaster and brick-dust, mixed with water. The mould is then opened, and the clay carefully removed. The mould, with its core, are then thoroughly dried, and the core secured in its central position by short bars of bronze, which pass into it through the external part of the mould. The whole is then bound with iron hoops, and, when placed in a proper situation for casting, the melted bronze is poured in through an aperture, and, of course, the bronze fills the cavity which was previously occupied by the clay, and forms a metallic covering to the core. It is afterwards made smooth by mechanical means.

SCURVY, a disease of a putrid nature, prevalent in cold and damp climates, and which chiefly affects sailors, owing to their being deprived of fresh provisions, and a due quantity of vegetable food. As it advances, the countenance becomes sallow and bloated; respiration is hurried on the least motion; the teeth become loose; the gums are spongy; the breath is very offensive; livid spots appear on different parts of the body; old wounds, which have long been healed up, break out afresh; severe wandering pains are felt, particularly by night; the skin is dry; the urine small in quantity; and the pulse is small, frequent, and, towards the last, intermitting. In the cure, as well as the prevention of scurvy, more is to be done by regimen than by medicine, particularly providing the patient with wholesome diet, and a large proportion of fresh vegetables; and it has been found that those articles are especially useful which contain a native acid, as oranges, lemons, and lemon-juice, as citric acid, now generally used.

SCURVY-GRASS, when green, is a diuretic, either as an infusion, or as a salad, and used to check scurvy.

SEA-AIR.—Those who frequent the sea-coast are not long in discovering that their best-dyed black hats become rusty brown; and that similar effects are produced on some other colours. The brown is, in fact, *rust*. Most, if not all, the usual black colours have iron for a basis, the black oxide of which is developed by galls, logwood, or other substances containing gallic acid. Now, the sea-air contains a proportion of the muriates over which it is wafted; and these coming into contact with any thing dyed black, part with their *muriatic* acid, and form brown hydromuriate of iron, or contribute to form the brown or red oxide called rust. The gallic acid, indeed, from its superior affinity, has the strongest hold of the iron; but the incessant action of the sea-air loaded with muriates, partially overcomes this, in the same way as any acid, even of inferior affinity to the gallic, when put upon black stuff, will turn it brown.

Sea-air is eminently restorative to the inhabitants of inland districts, and especially useful in many disorders of town-bred children. Hence the wise resort to the sea-shores by valetudinarians, and the rapid increase of our pleasure towns of Brighton, Worthing, Margate, St. Leonard's, Weymouth, &c.

SEACOLE, grows naturally on the sea-coasts in many parts of England. It may be propagated by cuttings of the roots. Cuttings of which, about two or three inches long, may be planted during any of the winter months, in rows about eighteen inches apart, at about six inches in the rows; putting the whole of the cuttings beneath the surface of the ground. These will make plants in two years. The best way is to raise the plants from seed. The seeds are light husky things about the size of peas. They must be sown in drills about eighteen inches apart, sowing the seeds thinly in the drills. When the plants are up, thin them out gradually, and ultimately to nine inches distance. In two years they will be fit to blanch; which is done in various ways, by covering the crowns, after the leaves have fallen off, in November. Some cover with pots, ashes, earth, sand long litter, or leaves.

SEA GIRDLE-AND-HANGERS, a marine plant, contain a saccharine jelly, eaten both by man and beast; and, also, burned for kelp.

SEALING-WAX. To make red, take of camphor, 4 oz.; Venice turpentine, 2 lbs.; vermilion, $1\frac{1}{4}$ lb.; rectified spirit of wine, 16 oz. Dissolve the camphor, first, in the rectified spirit of wine in a suitable vessel, over a slow fire, taking care that no flame touches the evaporating spirit: then add the shell-lac; and when that has become of an uniform smoothness, by a moderate application of heat, add the Venice turpentine, and lastly, the vermilion, which should be passed through a hair-sieve held over the melted mass, in order that it may not get into clots. When the whole is well incorporated, it may be formed into sticks.

It is usual to weigh out the soft wax into balls, and roll them on a table into the lengths desired, and then flatten them by pressure. They are polished by being held over a charcoal fire in a chafing-dish, then drawn over a tallow candle, and rubbed with soft leather.

*To make black.*—Instead of vermilion employ *lamp-black*. *Black resin* is also often used in about one-third the quantity of the shell-lac, thus:—Take of camphor, 1 oz.; shell-lac, $2\frac{1}{2}$ lbs.; black resin, $1\frac{1}{4}$ lbs.; oil of turpentine, 8 oz.; rectified spirit of wine, 8 oz.; lamp-black, 4 oz. Dissolve the camphor in the rectified spirit of wine, then add the shell-lac, to which pour the resin previously melted, and mixed with the oil of turpentine; using, of course, a moderate heat, and taking care that no flame touches the melting matters.—*Tingry.*

SEED, is the ovulum arrived at perfection, and consists of an integument enclosing an *embryo*, which is the rudiment of a future plant. The seed is nourished by the same means as the fruit; and, like it, will be more or less perfectly formed, according to the abundance of its nutriment.

When seeds are first ripened, their embryo is a mass of cellular substance, containing starch, fixed carbon, or other solid matter in its cavities.

The life of seed depends on a temperature above 32° Fahr., a moist medium, darkness, and exposure to air.

It then inhales oxygen, and undergoes certain chemical changes; its reactions cause it to ascend, by one extremity, for the purpose of finding light, and of decomposing its carbonic acid, by parting with its accumulated oxygen, and to descend by the other extremity for supply of crude nutriment.

Seed should be the ripest grain, or that which falls by simply shaking. Seed from a distance exceeds, in produce, that produced on the same land 25 per cent. This rule runs through animal and vegetable nature, and is only violated by aristocratic and royal races. In wheat $2\frac{1}{2}$ bushels per acre is sown in September, and a gallon added every fortnight after. Three is the average. Barley the same. Oats nearly double. Beans and peas 4. Clover-seed 10 or 12 lbs. Floating on water, or salt and water, detects bad seeds. Autumnal sowing is recommended by Sir John Sinclair for all grain, as a security against insects, taking less seed, &c. &c. Sowing is broadcast, and ploughed in, or dropt in the furrow after the plough, and covered on the return. Drilling by machines is excellent, with hoeing. Dibbling suits beans, peas, &c. Transplanting nearly doubles the crop.

In sowing land, well drained and prepared, for grass, seed should not be stinted. Ten lbs. of red clover, 10 of white, 10 of trefoil, and 3 pecks of rye grass per acre assure rich herbage.

Selection is the principle for procuring seeds. A vigorous wheat plant, near the centre of a field, has produced 2,473 grs. These were dibbled in the autumn of the same year, the produce sown broadcast the second and third years, and the fourth harvest produces 40 quarters of sound grain from this single plant. A fine purple-topped Swedish turnip produced 100,296 grains, which was seed enough for five acres, and thus in three years one turnip would produce seed enough for all Great Britain for a year.

Birds will not approach newly-sown beds, if twine on tops of short sticks is extended here and there, which has been dipt in a mixture of gas-tar, brown spirits of tar, and grease.

An examination of many common plants shows how scattering or dissemination takes place. Many seeds are furnished with plumes or wings; such as dandelion, groundsel, ragwort, thistles, &c. which are borne upon the winds far and wide. Others, as common burs, contain seeds which are furnished with hooks, and thus lay hold upon passing animals, and are scattered in distant places. Many seeds are contained in berries, which being eaten by birds, the seeds are discharged uninjured;—and others again are thrown out from their parent plant by strong elastic springs.

SEIDLITZ POWDERS, consist of 2 grs. of tartarized soda, and 2 scr. of carbonate of soda in the white paper; and of 35 grs. of tartaric acid in the blue paper, both to be mixed in a pint of water. But Dr. Paris states, that the waters of Seidlitz consist of sulphate of magnesia, muriate of magnesia, and sulphate and carbonate of lime.

SENNA, an annual species of cassia, which flourishes in Nubia and Bornou. It affords 2 crops of leaves in the year, and, in commerce, 2 or 3 sorts are always mixed before they are exported from Alexandria. It is an efficient purgative, but is apt to gripe, which may be corrected by ginger, or by infusing in cold instead of hot water. Sometimes the leaves are taken as powder, but the infusion is more common. It is also prepared as an electuary, a confection, a tincture, and a syrup. *Cathartine* has been obtained from it.

*Senna-Tincture.* In 1 pint of alcohol infuse 1½ oz. of senna-leaves, and of sun raisins, (stoned,) and 1 dr. each of caraway and lesser cardamom-seeds.

SEPARATION, in chemistry, is effected by the accurate knowledge of the bodies. Thus sugar, starch, pounded marble, and sand may be separated, the sugar by solution in water, the starch by boiling, and the marble by dilute muriatic-acid, the sand remaining.—*See* PRECIPITATION.

SESAMUM, is a plant cultivated extensively, on account of the seeds, and an oil which they yield, not unlike the oil of almonds; which will keep many years, and does not acquire any rancid smell or taste, but, in two years is a good substitute for olive-oil. In Jamaica it is called *vanglo*, or *oil-plant*; and the seeds are frequently used in broths. In Japan, China, and Cochin-China, where they have no butter, they use the oil for frying-fish, and in dressing other dishes. Pliny speaks of it as equally good to eat and burn. Nine pounds of seed yield two pounds of oil.

SHAGREEN, is made from the skins of asses.

SHALLOTS, a herb, whose roots are used as a sauce.

SHAVING LIQUID. Mix 4 pounds of soft-soap with 5 pints of alcohol.

*Royal Essence for Shaving.* One pint of alcohol and 8 oz. of Castile soap.

*Shaving-Paste.* Melt together, 1 dr. each, of almond-oil, white wax, and spermaceti, and, while warm, beat up with 2 oz. of rose-water, and add a square of Windsor soap.

SHAWLS, an article of dress and decoration, worn in India by men and women. They are a very ancient fabric, and made by the Hindoos with simple tools; but those of unrivalled fineness are made, in Cashmere, of goats' hair, spun by hand, equal to Nos. 200 or 250, which our machinery cannot reach.

SHAWLS, *British*. "Huddersfield has, within these 12 years, succeeded in the manufacture of all descriptions of shawls, from the common Valentia, which sell from 5*s*. to 6*s*., to the superfine *Thibets*, or Cashmeres, from 15*s*. to 21*s*. per yard, equal in delicacy, and softness of texture, to any shawls which, hitherto, have been imported from the north of India. But they are now made, as regular articles, by FROST, NELSON, & Co. of Huddersfield. It is delightful to enter their manufactory, and behold the prodigious variety of elegant shawls which are furnished every week for the London market. They begin with the rough wool, scour, prepare, weave, dye, and finish it. Their common shawls are wove with a cotton warp, No. 50, and a worsted weft, Nos. 28 to 38. Others, called Merinos, have spun silk warps, Nos. 70 and 72, and worsted wefts, Nos. 70 and 72. Their finest shawls, or *Thibets*, are woven from the finest Saxony wool; the warp No. 70 well twisted, and the weft 120. These Nos. are spun at Bradford, though, within these seven years, no worsted was spun higher than 50, but No. 120 is now a sound thread.

Shawls which require borders are supplied with them in London, the borders being made, of all patterns, at Paisley, Edinburgh, and Norwich; and, at those places, borders are a considerable and particular branch.

I saw very neat shawl-handkerchiefs, half square, with printed borders, as low as 7*s*. 6*d*. per dozen. They also make British Cashmeres, at 8s. 6d. per yard, from fine spider cotton warp, No. 70, and fine merino weft, Nos. 70 and 74.

The fine narrow cloths, called Royal Cashmere, for summer coating, are also made here, of Saxony wool, in worsted weft, No. 70, and No. 26 warp.

Of the Thibet shawl-cloth a weaver cannot make above a yard and a half per day, but of other shawl-cloth about five yards. The whole are dyed in the piece, and dyeing, through all this country, is carried to the highest perfection.

Another house, that of Mr. SWALLOW, also makes different kinds of common shawls in great perfection. This description is made plain, and then printed with blocks. The number made every week, by this house, was about 180 dozens, besides Thibets and half-handkerchiefs.

I learnt, also, that many common shawls are embroidered by women, who get about 1s. per day, besides girls for fringing, at 6d. or 8d. per day.—*Sir R. Phillips's Tour*, 1829.

SHEATONLOU, is the name of an African tree, the boiled kernels of which yield excellent butter.—*Park.*

SHEEP, a very numerous breed of animals, used by most men for food. They fatten at the rate of 10 oz. per acre per day, or yield 228 lbs. of mutton per annum, which, at 4d., is 3l. 16s., or at 5d., is 4l. 15s. independently of fleece, lambs, and value of 24 lbs. of offal. But they are much diseased, and subject to frequent mortality. It is supposed that there are above30 millions in the United Kingdom. The weight of fleece varies from 3 to 9 lbs., worth from 9d. to 4d. per lb., and useful for blankets, carpets, flannel, baize, worsted, ropes, &c., all fine cloths being necessarily made from Saxony wool. The Merino, or Spanish, produce the best wool, but the wool deteriorates in England, while it improves in Saxony, Silesia, Bohemia, &c. Chalk and silicious soils give harshness to wool, but the argillaceous render it soft and fit for milling.

SHIP. In merchantmen, the primary consideration is, to attain the greatest capacity to carry cargo, combined, as far as possible, with safe and easy movements, and rapid sailing. In this way the American builders have succeeded in uniting conflicting *desiderata* in a degree heretofore deemed impossible. Their packet ships carry enormously, while their extreme speed has reduced, by half, the passage to Europe.

The greatest breadth must always be before the centre, and consequently, the bow be more blunt than the stern. The best builders place this point only one-third of the length from the stem. Experience proves, that it is essential to facilitate the escape of the displaced water along the side of the vessel; for, when once a passage is opened for the ship, the fluid tends to re-unite abaft, the point of greatest breadth, where, instead of offering resistance, it presses the ship forward, in its endeavour to recover its level, and fill the vacuum constantly opening behind her. A log tows infinitely easier by its bigger end; and we find a concurrent testimony in the forms of the finny tribe, which divide the element they move in, by a shape gradually diminishing from head to tail. There is a further advantage, in having the bow full towards the edge, that in may check descending into the waves, not abruptly, but gently; pitching being the most dangerous to hull and spars of all movements. Sharpness towards the sternpost is vitally essential to fast sailing. Stability increases as the cubes of the breadth; hence, by adding one quarter to the breadth, you gain a double stability, and, by consequence, a capacity to bear twice as much sail, with but one-fourth of increase in the resistance. The pressure of the water increases in descending from the surface, and, from this cause, and the augmented difficulty of displacing it, the resistance offered to a ship, in advancing, is three times as great at the lower as at the upper half of the immersed section. An extreme in breadth, as in length or depth, is also dangerous, and both extremes are to be equally avoided.

The builder forms a half model of his proposed ship, making it a quarter of an inch to the foot. Moulds are then formed of all the different parts. In the United States, where there are abundant supplies, builders confine themselves to live oak, pine, chesnut, locust, and cedar. The tree should be taken in the second era of its growth, when it has attained maturity, without approaching the period of decay. It should be killed, by removing a ring of bark, at the beginning of winter, when the sap is down, and left to dry and harden before it be cut down.

In laying down the keel, great care must be taken to preserve its perpendicularity, for which purpose it is pinned with treenails, on either side of the blocks; also in raising and propping the stem and stern, and every piece of the frame. As the floor timbers are the great connecting principles of the ship, to which they bear the same relation as the ribs to the body, too much care cannot be taken in selecting and securing them. Sometimes the frame is made completely solid, and calked; and, in this case, the interior covering of plank is dispensed with, excepting a few strengthening streaks.

The planking does not merely serve

to exclude the water, but to protect, connect, and bind harmoniously together, and is quite as essential as the skin to the body. It is one of the nicest arts of the builder, so to carry up his planking, as with little waste, to keep his seams always fair with the water-lines. When it is necessary to bend a plank at the bow or stern, it is heated by steam, and then forced into place with screws and levers. All being complete, the carpenter makes room for the calker, who carefully stops all the seams with oakum, and smears them with pitch. The scraper follows the calker. Sheathing with wood is practised with iron-fastened ships, because copper causes the bolt heads to corrode, if placed against them. It consists, simply, in covering the bottom with pine boards, sheets of paper, soaked in hot pitch, being placed between. In sheathing with copper, paper is also interposed. The plates overlap each other from bow to stern, to prevent their being stripped off by the continual shock of the passing water.

The *first-rate* is a ship of the line, of one hundred guns and upwards, having three decks or tiers of guns; and the seventy-four is of the line, but third-rate, with two decks or tiers of guns. The *gun-vessel*, the sixth or smallest rate, is rigged like a sloop of war. The *brig* has only two masts, which are rigged like the main and fore-mast of a ship, but has a fore and aft main-sail. A *snow* only differs from a brig by having a try-sail, which hoists upon a small mast abaft the main-mast, and thereby can carry a square main-sail. A *ketch* has two masts, similar to the brig, but has no fore-mast, but a main-mast and a mizen-mast rigged as a ship's. The *lugger* has two masts, with square sails, that are hoisted by their yards, not in the middle, as vessels in general, but at one-third of their length. *Schooners* are vessels of a similar size to luggers, having two masts, whose main-sail and fore-sail are suspended from gaffs at the head; and the foot stretched out by a boom, like a man-of-war's long-boat. *Sloops*, or vessels, have one mast, have a main-sail, fore-sail, and jib, as the man-of-war's long-boat.

Stability and swiftness are the first and principal points of the naval architect, and stability claims precedence before speed, because safety depends on the former, and only convenience on the latter.

If we compare the carcase of a ship to the skeleton of the human body, the keel may be considered as the back-bone, and the timbers as the ribs. It, therefore, supports and unites the whole fabric, since the stem and stern-post, which are elevated on its ends, are, in some measure, a continuation of the keel, and serve to connect and inclose the extremities of the sides by transoms; as the keel forms and unites the bottom by timbers. The keel is generally composed of several thick pieces, placed lengthways, which, after being scarfed together, are bolted and clinched upon the upper side. When these pieces cannot be procured long enough, to afford a sufficient depth to the keel, there is a strong thick piece of timber bolted to the bottom, called the false keel.

A new era has taken place in the art of ship-building; and we are indebted to Sir Robert Seppings for some of the most important improvements in marine architecture, which have characterized the present century. Several large ships have already been rebuilt at Chatham on his principle, and orders have been given for building several new ships.

1st. The frame of a 74-gun ship, used to be formed of more than 800 different timbers, placed at right angles to the keel, which may be considered as the back-bone of an animal, and the frame-timbers its ribs. Each rib is composed of several pieces, of the thickness of 14 inches, or thereabouts. Between the several divisions of the frame or ribs, is a space from 1 to 5 inches wide.

2dly. The whole exterior frame was covered with planks of different thicknesses, or to carry on the figure, the ribs are covered by a skin of greater or less substance, from the extreme ends of them, to the keel or back-bone. The inside of the frame was also almost entirely lined with planks; within which is another partial range, as it were, of interior ribs, at a considerable distance from each other, termed riders.

3dly. Across this frame were pieces of timber called beams, united together so as to be of sufficient length to reach from one side of the ship to the other.

From this account, it will be perceived that all the materials composing the fabric of a ship are disposed nearly at right angles to each other. And this disposition, which is well known to be the weakest, is particularly so in a ship, the immense body of which, subject to violent action from impulses in every direction, is sustained by a greater pressure on the centre than the extremities, arising chiefly from the difference in the fore and after parts of the body, to that of the midship, or middle part.

The length of a 74-gun ship being 170 feet or more, it requires but little knowledge of the strength of timber to perceive that planking of that length, however thick, or in whatever way joined or put together, must, under the present system, bend with its own weight. The fastenings, and, consequently, the connection of the several parts of the fabric, must therefore suffer for the want of *stiffness*, and a change of form is the consequence.

This may be shewn by putting together four pieces of wood, and the securing them with iron pins in the form of a square; which, on the least pressure, may be made to change its form to the rhombus; but let another piece be fixed to it *diagonally*, and the figure of the frame will be found *immoveable*. Place a bar in the middle, parallel to two of the sides, and secure it firmly by iron pins; still the figure will easily be moved by the hand, *like a parallel ruler*, and assume the rhomboidal shape; but apply to the frame what the carpenters term *the brace*, as in a common field-gate, and the figure will remain immoveable. And if this brace or diagonal piece is not fixed to it, the outer part of the gate (or that part most distant from the hinges) will have a constant tendency downwards, until at length it will reach the ground.

The substitution of *the triangle*, or brace, for the rectangle, comprehends *the principle of the new system*.

The arrangement of the materials in the triangular mode is such, that the pieces disposed horizontally are acted upon as ropes are by a strain of the fibre, whilst the other parts, composing a series of triangles, are pressed upon as pillars; in other words, the pressure acts in the direction of the fibres of the wood; whereas, upon the rectangular, or old plan, the fibres are acted upon transversely, or across the grain, in the same manner as a stick is when placed across the knee, and pressed by the hands at each end, which first bends, and then breaks.

To prevent any transverse action upon the fibre of the timber, is one of the benefits arising from the new system, and to impede a longitudinal extension of the structure, is another. In a word, *the system of triangles* is so constructed, in conjunction with the planking of the ship, as conjointly to possess that property of a triangle already explained, viz. *that its figure is as unalterable as the compression or extension of the fibre of timber will admit it to be.*

In the new system, the openings between the ribs are filled in with slips of timber nearly to the height of the orlop, or lower tier of beams; which, being then caulked, and paid or pitched over, makes the frame from head to stern, and within a few feet of the greatest draught of water, one compact and water-tight mass of timber; so that were any of the outer planking of the bottom to be knocked off, the ship would not only still keep afloat, but would be secured from sinking. In the old system, the starting of a plank would be, and often has been fatal.

The mode of filling in these openings between the frame, where the width of the space does not exceed three inches, is by driving in slices of wood cut wedge-like: two of which being driven, one from the outside, the other from within, form the parallel space of the opening, thereby bringing the parts into the closest contact. In the openings exceeding the width of three inches, the space is occupied by pieces corresponding with the openings, the fibre of such pieces being laid in the same direction as that of the frame timbers.

These fillings occasion no consumption of useful timber, as one-fourth of the produce of slab and other offal, now sold as fathom-wood, would supply a sufficient quantity for the consumption of the whole navy.

Pieces of timber are next placed in a fore and aft direction over the joints of the frame-timbers, at the floor and first futtock-heads, their ends in close contact with, and coaked or douelled to the sides of the diagonal timbers. In this state, the frame-work in the hold prevents various compartments, each representing the figure of a rhomboid.

A truss-timber is then introduced into each rhomboid, with an inclination opposite to that of the diagonal timbers, thereby dividing it into two parts. The truss-pieces, so introduced into the rhomboid, are to the diagonal frame what the key-stone is to the arch; for no weight or pressure on the fabric can alter its position in a longitudinal direction, till compression takes place at the abutments, and extension of the various ties.

This arch-like property of the diagonal frame not only opposes an alteration of position in a longitudinal direction, but also resists external pressure on the bottom, either from grounding or any other cause, because no impression can be made in its figure in these directions, without forcing the several parts of which it is composed into a shorter space.

The connection which is kept up by means of this trussed frame, firmly attached to the timbers of the ship by circular coaks and bolts, together with the shelf-pieces united to the sides, and to the several beams by means of the same sort of fastenings, gives such unity to the whole, as to bear no comparison with that heterogeneous and badly-connected mass of materials for which it is substituted.

In the decks, the beams are disposed in the new system nearly as usual, except that in midships, where a ship necessarily requires the greatest security, two additional beams have been introduced.

This mode of strengthening ships may be compared to that of a raft firmly secured in the first place by strong lashing, which after some time works loose, or rather by working is stretched. As it might be too tedious a business to secure the raft by retightening the lashing, a small cord, or some twine, would be used to answer the purpose. It is clear, that whilst the small cord or piece of twine remained tight, no part of the strain can bear upon the strong but loose lashing, till the other stretches or breaks; so it is with a ship that has additional securities given her, without refastening those which had worked, or were much strained.

Such is Sir Robert Seppings' mode of constructing large vessels, and he has developed also a similar new principle of constructing ships for the mercantile service.

The principle of Sir R. Sepping renders the component parts of each rib of shorter length, and less curvature, consequently less graincut; and more firm and solid by the substitution of coaks or douels, for chocks or wedge-pieces; while the mode of connecting the lower timbers is better adapted, in the event of a ship grounding, to give support and strength to the fabric. The plan of connecting the ends of the timbers, by circular douels or coaks is simply that which is practised to unite the fellies of carriage-wheels.

Ships are deemed British only when three-fourths of the crew, exclusive of the captain, are British subjects.

Chinese ships cannot be bilged, for they divide the interior by strong partitions, water-tight; so that water entering one or two does not affect the rest of the divisions; and a wrecked vessel floats at the next high-water.

The relative proportions of masts to the stability of ships, and to the resistance to be overcome, are, for the foremast, 1-9th of the length of the ship from the stern, the mainmast 5-9ths, and the mizenmast 6-7th ; the length to be taken at their line of flotation. The best proportion of length to breadth of three-mast ships is 3·75 to four times their breadth : for length in brigs, 3·27 times their breadth for length ; and cutters only three times as long as they are broad.

The Gannet man of war has been sheathed with sheets of zinc, instead of copper. The sheets are of the same size as copper, but, from its brittle nature, it was necessary to soften it, for the purpose of perforating the holes, the nails, also, being principally of zinc. The expense is about half that of copper.

In passage-ships, in long voyages, regulations like the following are adopted :

1. Breakfast to be at 8 o'clock, dinner at 1, tea and supper at 5.

2. All lights are extinguished at 9; but one lantern locked (the key in charge of the officer of the watch,) is kept burning for the accommodation of the sick.

3. No smoking is allowed between decks.

4. Great care to be taken that there be no waste of the fresh water.

5. Intemperance in drinking is carefully to be avoided; and any breach of decorum, arising from this cause, to be punished by the supply of spirits being withheld from the persons offending.

6. Cleanliness is to be particularly observed in the 'tween decks, and the passengers are constantly to air their bedding.

*The following is the weekly allowance to a male passenger, three-fourths to a female, and half to a child.*

| | *lb.* | *oz.* | | *lb.* | *oz.* |
|---|---|---|---|---|---|
| Bread..... | 7 | 0 | Tea ........ | 0 | 3 |
| Pork ...... | 2 | 8 | Plums ...... | 0 | 8 |
| Beef ...... | 3 | 8 | Peas ..... | 1½ | *Pints.* |
| Flour or Potatoes | 1 | 8 | Oatmeal .. | 0½ | " |
| | | | Rice ...... | 0½ | " |
| Suet ...... | 0 | 8 | Vinegar .. | 0½ | " |
| Sugar..... | 0 | 12 | Rum ..... | 1¾ | " |

Water 7 galls. for cooking and waste.

If the whole rations of beef and pork are not drawn a proportionate increase of other provisions is allowed.—1½ lb. of peas, 1½ lb. of flour, 1½ lb. of biscuit, or 1½ lb. of rice ; equal to 1 lb. of beef or pork.

SHIP-WORM, or terèdo navàlis, is the only one which has excited notice by its destructive powers. This shell-enclosed worm, which Linnæus styled the *calamitas navium*, was introduced into our seas, from the East, within little more than a century. They are now common in all the seas of Europe ; and, having the power of perforating wood, they have done extensive mischiefs to ships, piers, and all submarine wooden buildings. The soundest and hardest oak cannot resist them ; but, in the course of four or five years, they will drill it. In the years 1731 and 1732, the United Provinces were under alarm, for it was discovered that these worms had made such depredations on the piles which support the banks of Zealand, as to threaten them with total destruction.

SIALOGUES, are medicines, which promote the discharge of saliva.

SIEVES, Brewer's Patent, are a series, one above the other, so as to exclude knots, or coarse fibres in the pulp ; they are acted on by a crank with machinery, so as to receive vibratory motion.

SILICON, is the base of silica, or quartz, or silicious sand, which is an acid of silicon. It is chemically decomposed from fluor spar, heated with sulphuric acid, forming fluosilicic acid. It is a deep brown powder, resembling boron, the base of the salt borax. As the acid silica, it combines with alkalies, in making glass; and silicon combines with nitric and fluoric acid; the action of the latter on glass is a consequence.

Rock crystals are the purest specimens of silicious earth.

SILK, was brought from China, whence the silk-worm was introduced, by two Persian monks, who succeeded in secretly conveying a number of the eggs to Constantinople, in a hollow cane, in 552. From these eggs Europe and America have been supplied with worms. The Chinese ascribe the invention to the empress Si-ling-shi, wife of Hoang-ti, about 2700 years before the Christian era.

SILK-WORM, a caterpillar, which, in due time, undergoes its metamorphoses, and becomes a moth, like others of the genus. At birth, for the first ten days, the colour of the worm is blackish or obscure. As it grows, it casts its skin at stated periods, and turns whitish or bluish, and, when ready to spin, becomes yellow. It is covered with scattering hairs, and has a little fleshy tubercle on the upper part of the last ring. It feeds on the mulberry. Before spinning, it fasts for 36 hours, voids all its excrements, becomes soft and flaccid, and seeks a suitable place for the construction of its cocoon. Two or three days are occupied in this work.

The worm then changes to a chrysalis, and, after remaining twenty days, the moth comes out, forcing its way through the cocoon. The males first appear, and are very brisk in their motions, but do not fly, at least in cold climates. They live but a few days, and the females perish, also, as soon as they have deposited their eggs. The eggs are attached, often to the number of 500, or more, by means of a gummy substance, and hatch in the ensuing spring.

After the worm has enveloped itself in the cocoon, seven or eight days are permitted to elapse before the balls are gathered; the next process is to destroy the life of the chrysalides, which is done either by exposure to the sun, or by the heat of an oven or of steam. The cocoons are next separated from the floss, or loose downy substance, which envelopes the compact balls, and are then ready to be reeled. For this purpose, they are thrown into a boiler of hot water, for the purpose of dissolving the gum, and, being gently dressed with a brush, to which the threads adhere, the reeler is thus enabled to disengage them. The ends of four or more of the threads thus cleared are passed through holes in an iron bar, after which two of these compound threads are twisted together, and made fast to the reel. The length of reeled silk, obtained from a single cocoon, varies from 300 to 600 yards; and it has been estimated, that 12 lbs. of cocoons, the produce of the labours of 2800 worms, who have consumed 152 lbs. of mulberry-leaves, give 1 lb. of reeled silk, which may be converted into 16 yards of gros de Naples.

Those cocoons which have been perforated cannot be reeled, but must be spun, on account of the breaks in the thread. The produce of these balls, when worked, is called *fleuret.*

The raw silk, before it can be used in weaving, must be twisted or thrown, and may be converted into singles, tram, or organzine. The *first* is produced merely by twisting the raw silk, to give more firmness to its texture. *Tram* is formed by twisting together, but not very closely, two or more threads of raw silk, and usually constitutes the weft or shoot of manufactured goods. *Organzine* is principally used in the warp, and is formed by twisting, first, each individual thread, and then two or more of the threads, thus twisted, with the throwing-mill. The silk, when *thrown*, is called *hard silk*, and must be boiled, in order to discharge the gum, which, otherwise, renders it harsh to the touch, and unfit to receive the dye. After boiling about four hours in soaped water, it is washed in clear water, to discharge the soap, and is seen to have acquired that glossiness and softness of texture which forms its principal characteristic. The yarn is now ready for weaving.

Silk-worms are fed, in France, on the leaves of the white mulberry, planted in hedge-rows, as pollards, and raised from seeds by nurserymen. The eggs are hatched in rooms, heated to $72\frac{1}{2}°$ F. One ounce of eggs consume 1 cwt. of leaves, and produce from 7 to 9 lbs. of raw silk, which is wound off the cocoons by women and children. The season is May.

The silk-worm is now propagated in the United States, and even so far north as 45° there is a mulberry-orchard of 100 acres, and considerable produce of silk, $8\frac{1}{2}$ dollars per lb.

Silk-worms may be reared with success on the leaves of the scorsonera, or with acer tartarium.

Satin is a silk twill of peculiar description, the soft and lustrous face of which is given by keeping a large proportion of the threads of the warp visible. When first taken out of the loom, satins are somewhat flossy or rough; and they are dressed by being rolled on heated cylinders, which operation gives them their brilliant lustre.

*Watering silk* is performed by passing two pieces of silk, placed lengthwise, one on the other, between two metallic rollers: the different parts are thus subjected to different degrees of pressure, from which the wavy appearance results.

Silk is *embossed* by passing the plain stuff between rollers, the surfaces of which contain the desired pattern, on one cylinder raised, and on the other sunk, so that the eminences of the one coincide with the depressions in the other.

SILVER, a metal which occurs very frequently in a state of purity in the earth, and requires but ordinary heat for its fusion. There are five ores of silver, viz.—1. *Native Silver*; 2. *vitreous silver*, (or silver glance;) 3. *black silver*; 4. *red silver*; 5. *horn silver*.—*Native silver* is occasionally found crystallized, and occurs principally in veins, traversing gneiss, clay-slate, and other primitive and transition rocks. *Vitreous silver* presents itself crystallized, and it has been hitherto found almost exclusively in veins, along with ores of lead, antimony, and zinc. *Black silver* consists of silver 65·5, antimony, iron, sulphur, and copper and arsenic. *Red silver* is often found massive, granular, and even impalpable. It consists of silver 59, antimony, and sulphur. It occurs in veins, along with other ores of silver, galena, and blende. *Horn silver* occurs in crusts and granular masses, and consists of silver 76·0, oxygen 7·6, and muriatic-acid 16·4. It is found in the upper parts of veins in clay-slate, but occurs also in beds, generally along with other ores of silver, or with iron-ochre. Argentiferous sulphurets of lead and copper are sometimes smelted, for the small proportion of this precious metal which they contain.

*Smelting* is founded on the great affinity of silver for lead, which, when fused with silver, acts as a solvent, and extracts it from its union with baser metals. The silver is afterwards separated from the lead by cupellation, which consists in exposing the alloy to a stream of atmospheric air, by which the lead is converted into an oxide or litharge, while the silver remains.

*Amalgamation* succeeds best when the silver produce is about seventy-five ounces to the ton of ore; at the same time, regard being had to the quantity of sulphur present, which is ascertained from the quantity of sulphuret in the ore, previously learned by an assay in the crucible. The sulphur is got rid of, by adding to the mixture of raw ore ten per cent. of common salt, by which, during the furnace operation, the sulphur becomes acidified, and the acid, thus formed, uniting with the base of the salt, forms sulphate of soda; whilst the muriatic acid, thus set free, combines with the silver in the ore, that was not in the metallic state, and forms muriate of silver. In this state, the ore is subjected to various mechanical operations, with riddles, mills, and sieves, until it is reduced to an inpalpable powder. It is then submitted to the action of mercury, in barrels, which revolve on their axis. The charge, in each barrel, consists of sifted calcined ore, mercury, metallic iron, and water. The ore is composed of sulphate of soda, muriate of silver, and other metals and earthy matters. The barrels being made to revolve sixteen or eighteen hours, the muriate of silver becomes decomposed by the action of the iron on its acid; and the silver, thus reduced to the metallic state, combines with the mercury, forming what is termed *amalgam*, whilst the sulphate of soda, the muriate of iron, and other salts, become dissolved in the water. The silver, combined with mercury, is then filtered, by which the surplus metal is separated, and a compound remains in the sack, consisting of six parts of mercury, and one of silver. This amalgam is subjected to the action of heat in a distilling furnace, by which the mercury is sublimated, and the silver remains.

Pure silver is of a fine white colour, with a shade of yellow, without either taste or smell, and, in brilliancy, is inferior to none of the metallic bodies, if we except polished steel. It is softer than copper, but harder than gold. When melted, its specific gravity is 10·47; when hammered, 10·51. It is next in malleability to gold, having been beaten out into leaves only 1-100,000th of an inch in thickness. It may be drawn out into a wire, much finer than a human hair; so fine, indeed, that a single grain of silver may be extended about 400 feet in length. Its tenacity is such, that a wire of silver, 0·078 of an inch in diameter, is capable of supporting a weight of 187·13 pounds avoirdupois, without breaking.

Silver melts when heated completely red-hot. If the heat be increased after the silver is melted, the liquid metal boils, and may be volatilized. When cooled slowly, its surface exhibits the appearance of crystals; and, if the liquid part of the metal be poured out as soon as the surface congeals, pretty large crystals of silver may be obtained.

Silver is not oxidized by exposure to

the air: it becomes tarnished, owing to a different cause; but, if kept for a long time melted in an open vessel, it gradually absorbs oxygen, and is converted into an oxide.

When silver is dissolved in nitric acid, and an alkali dropped into the solution, a brown-coloured precipitate falls in flocks, which, when washed and dried, is the *oxide of silver*, and when exposed to the direct rays of the sun, it gives out oxygen gas, and is converted into a black powder. When thin plates of silver and sulphur are laid alternately above each other in a crucible, they melt readily in a low red heat, and form *sulphuret of silver*. Its colour is black, and it crystallizes in small needles. It is capable of being cut with a knife, and is more easily fused than silver. When silver is long exposed to the air, especially in frequented places, it acquires a covering of a violet colour, and when 500 parts of steel are fused along with one part of silver, the compound is greatly improved for the purposes of cutting instruments.

Nitric acid is the proper solvent of this metal, from which solution other salts of silver are obtained; it dissolves more than half its weight of the metal, the solution being attended with effervescence: if the silver and the acid are pure, the solution is limpid and colourless, exceedingly heavy and caustic; it stains the skin, and all animal substances, of an indelible black colour; hence it is often used to dye hair, &c. Its taste is intensely bitter and metallic, and it is usually employed as a corrosive substance, under the name of *lunar caustic:* it is soluble in its own weight of cold, and in half its weight of hot water. From the solution, the silver is thrown down in a metallic state, by a great number of bodies; for example, hydrogen, sulphurous acid, sulphate of iron, proto-chloride of tin, carbon, phosphorous, volatile oils, and many of the metals. When heated, it readily melts, swells up, and then remains liquid: in this state it is cast into small cylindrical moulds by apothecaries, to be employed by surgeons for the purpose of opening ulcers, and destroying fungous excrescences: as an escharotic, its action is powerful, and it is greatly preferred to caustic potash also, in consequence of its not being liable to deliquesce and spread.

The *salts of silver* are decomposed by the alkalies and the earths. Prussiate of potash, when dropped into a solution of a salt of silver, occasions a white precipitate: hydro-sulphuret of potash produces a black precipitate; and an infusion of nutgalls gives a yellowish brown precipitate.

*Fulminating silver*, is prepared by dissolving silver in nitrous acid, diluted with three parts of water: to the solution lime-water is added, as long as any precipitate is occasioned; the precipitate is washed and dried; it is then allowed to remain for several hours in liquid ammonia, when it becomes a black powder; the liquor is decanted, and it is allowed to dry in the air: when completely dry, such is its tendency to explosion, that it cannot be touched, the slightest agitation causing it to detonate; and so violent is the detonation, that the experiment cannot be made with safety on more than a grain. It probably consists of oxide of silver and ammonia, the elements being united by affinities so nicely balanced, that the slightest external force subverts them, and causes new combinations: the oxygen of the oxide unites with the hydrogen of the ammonia, and forms watery vapour; the nitrogen must assume the elastic form, and the augmentation of elasticity in these products may be the cause of the detonation.

Another *fulminating silver* is formed in the following manner: Into a pint tumbler, or other glass vessel, is introduced 100 grains of dry nitrate of silver, over which is poured one ounce of alcohol, and the same quantity of smoking nitric acid. The mixture of the alcohol and nitric acid occasions much heat and effervescence: if this is so violent as to overflow the vessel, cold alcohol is added, to abate the ebullition: in a few minutes the liquor becomes turbid, and a white crystalline powder falls down, which is separated by the filter, and thoroughly washed with tepid water: before being fully dry, it should be separated into parcels of 10 or 20 grains. The substance is white and crystalline; the light changes its colour to a dark brown; when heated, it explodes with great violence. It explodes also by percussion and friction, and the contact of sulphuric acid. When put into dry chlorine gas, it explodes with a loud report. No persons but chemists should venture upon its manufacture, or presume to experiment with it. It is composed of oxide of silver 14·75, and of a peculiar acid, called the *fulminic*, 5·25.

*Silvering copper*.—Rub it with the following powder:—Two drachms of tartar, the same quantity of common salt, and half a drachm of alum, are mixed with fifteen or twenty grains of silver, precipitated from nitric acid by copper. The surface of the copper becomes white, when rubbed with this powder, which may afterwards be brushed off, and polished with leather. *Or*, a cheap silvering is prepared as follows: Half an ounce of silver, that has been precipitated from aquafortis by the addition of copper, common salt, and muriate of ammonia, of each two ounces, and one drachm of corrosive muriate of mercury, are triturated together, and made into a paste with water; with this copper utensils of every kind, that have been previously boiled with tartar and alum, are rubbed, after which they are made red-hot, and then polished.

The dial-plates of clocks, the scales of barometers, and other similar articles, are silvered by rubbing upon them a mixture of muriate of silver, sea-salt, and tartar, and afterwards washing off the saline matter with water. In this operation, the silver is precipitated from the muriatic acid, which unites with part of the coppery surface. *Silvering of pins* is effected by boiling them with tin filings and tartar.

*To make shell-silver*, silver-leaf is ground with gum-water, or honey: the gum, or honey, is washed away, and the powder which remains is used with gum-water, or white of eggs, laid on with a hair-pencil.

*Silvering for looking-glasses.*—Looking-glasses are silvered by an extemporaneous amalgamation of tin and quicksilver. Tin-foil is placed on the back of the glass, and some quicksilver is poured upon it, and spread over the surface with a hare's foot. Another glass is then slid over the tin, to drive off part of the quicksilver; and paper and a board being laid on the tin, it is strongly pressed with a number of weights, to expel, by degrees, the superfluous quicksilver, and leave only a crystallized amalgam on the back of the glass.

*Silvering for globes.*—This amalgam is made by dissolving one pound of tin, glass, or bismuth, in four pounds of quicksilver. The globes to be silvered are thoroughly cleaned on the inside, and warmed; then the above amalgam being heated, so as to be perfectly liquid, is poured in by a paper funnel, and the globe inclined in various directions, that, as the amalgam crystallizes by cooling, it may adhere to all parts of the globe; the superfluous amalgam is then poured out.

*Silvering ivory.*—Immerse a slip of ivory in a weak solution of nitrate of silver, and let it remain till the solution has given it a deep yellow colour: then take it out, and immerse it in a tumbler of clear water, and expose it in water to the rays of the sun. In about three hours the ivory acquires a black colour, but the black surface, on being rubbed, is soon changed to a brilliant silver.

*Packfond, or German silver.*—This alloy is formed in various proportions; and it is harder, and less liable to alteration, the more nickel it contains. For example, we may employ one part of nickel, two and three-quarters' parts of copper, and three-quarters of a part of zinc. This last alloy is more difficult to work, on account of its hardness; but it is less liable to alteration. We must also observe, that the *packfond* is the better, accordingly as the zinc and copper, which enter into its composition, are the more pure; and, they affirm, that the presence of a little lead in the zinc greatly diminishes the malleability of the alloy.

*Or*, take thirty-two parts of copper, and eleven parts of nickel, in grains; put these into a covered crucible, and heat until complete fusion takes place. They must then be well stirred with an iron rod, to render the mixture homogeneous; and, when the whole is in complete liquefaction, it must be poured into water, and granulated. It is then to be well dried, and again placed in the crucible; and when heated to redness, eight parts of zinc are to be added; the whole is then to be covered with a proper defensive flux, and the fire must be urged by a strong blast; and, when the whole is well fused, the scorias must be removed, and the alloy be poured into an ingot mould.

To clean articles made of *packfond*, we may either use finely-sifted wood-ashes, tripoli, or ivory-black, well washed and sifted.

SINGLETON'S GOLDEN OINTMENT.—Mix equal weights of hog's-lard and orpiment (yellow sulphate of mercury.)

SIZE, (Strong) may be made by dissolving a pound of glue in 4 gallons of water, and then boiling in this a pound of the cuttings of glovers, or book-binders.

SKELETON, the frame-work of an animal, consists of bones, for various purposes essential to continuity of being, as cranium, vertebræ, arm-bones, thigh-bones, leg-bones, ribs, &c. united by cartilages or gristle, and connected by ligaments or cords of peculiar tenacity, with tendons to give continuity to the action of the muscles. This skeleton forms a lever between the limbs at one end or side, and the ground, as a fulcrum at the other end. It distributes the muscles, and developes the animal as a whole and in parts.

SKIN, the natural covering of animals, consisting of the outer skin, called the epidermis; or scarf-skin, without nerves; and the *cutis*, or true skin, a thick fibrous membrane, which, boiled, affords gelatine or glue. Leather is the union of tannin and gelatine, as it exists in the skin of animals. It is 48 carbon, 8 hydrogen, 17 nitrogen, and 27 oxygen. The epidermis, or outer skin, is 94 of albumen in 100 parts.

The skin is a very important part of

the animal economy; for, as all material phenomena are sustained by the action and reaction of oxygen and nitrogen, so the skin performs the functions of the latter and the venous system, while the lungs perform those of the former and the arterial system of all animals. The heart is the internal instrument of the oxygen action, and the liver of the nitrogen reaction; and in this way an animal lives, moves, and assimilates, as intermediate results. Then, as electrical action and reaction of separated and uniting oxygen and nitrogen, we trace the same mode of action in the animal economy. The skin facilitates, by its numberless pores operating as absorbents of the nitrogen, whose reaction, like that of negative electricity, is caused and kept up by the fixation and action of oxygen in the lungs, one rendering the blood venous and purple, while the other renders it arterial and red.

SKINS.—The conversion of skins into leather is explained in the articles FELLMONGER and TANNING, but, in Morocco, skins are dressed so as at once to preserve the fur, and give flexibility to the pelt. It is first washed, and all the flesh scraped off. 2 lbs. of alum, 1 quart of butter, melt, and half a gallon barley-meal are then mixed, and laid on the fleshy side, and the skin is folded, pressed, and kept for two days. It is then well-washed in salt and water, drained, 2 lbs. of roche alum spread over it, folded, and kept for three days. Afterwards, it is dried in the sun, and laid flat. It is then sprinkled with water and folded for two hours. It is completed by scraping off the mixture and flesh, rubbing with a roughish sandstone till pliable, and drying in the shade. The process in fine weather is often finished in three or five days. Solutions of alum, or alum and charcoal, cure the horns, the cavities of the head, &c. while the process is going on.

SLATES, for roofs, are trimmed, shaped, and bored by the slater. The roof is boarded with feather-edged weather-boards, and the slates are fixed with copper or zinc nails. A roof should incline from 12 to 25°. The best slate is bluish-grey; light-grey is stony and does not shape easily; black or dark absorbs wet, and quickly decays. They are for roofs, from 15 inches by 8, to 3 feet by 2 feet. The Welsh, Switzerland, and Kendal, are the best and largest.

SLUGS, (*to render harmless.*)—Slugs attack the leaf of a somewhat-withered cabbage, in preference to those in a more thriving condition. When a bed of cabbages is planned, strew the leaves that are cut off all over the bed, and the slugs will lie under them, and feed on them in the shade. Every day or two more leaves may be strewed.

SMALL-POX; an eruptive fever, which, in its pustules, engenders an infectious matter, by means of which the disease may be communicated to other persons, who have not been before attacked by it. This disease, as well as the measles, came first from Ethiopia to Arabia, about A. D. 572. In the first half of the seventeenth century, it passed to Egypt, and the crusaders introduced it into Europe.

The violence of the disorder, however, is lessened when it is produced artificially, by inoculation with the small-pox virus.

Recently, small-pox inoculation has been entirely superseded by vaccination; a species of the disease moderated in the constitution of the cow, but so mild as to require repetition after a few years, or it ceases to be a satisfactory security.

SMELL.—The sense of smell is that by means of which we perceive the fine effluvia which arise from bodies, and spread in the air. The delicate mucous membrane, which lines the internal parts of the nose, and through which the olfactory nerve, descending from the brain, is distributed, is the sole organ of this sense. The fine odoriferous effluvia of bodies are of incredible tenuity. With a portion of oil of lavender, the 12th of an inch square, we may perfume a chamber containing 3240 cubic feet. A piece of ambergris, weighing 100 grains, in an open chamber, with a free draught of air, fills it with odoriferous particles; and yet, not the smallest diminution of the ambergris is perceptible.

SMELLOME'S ointment for the eyes, consists of half a drachm of verdigris, finely powdered, with 30 drops of oil, mixed with an oz. of yellow basilicon.

SMOKY-CHIMNEYS.—The *first* effort towards the cure of *smoky chimneys* should be, to close up, as far as they can be got at, all those chambers or cavities left at the lower part; then to reduce the apertures—the upper one in particular, as much as possible. *Second*, to draw the grate more forward into the room; which will have the effect of heating the air in the apartment much more, and will give a horizontal direction to the smoke, and an impetus ere it arrives at perpendicular ascent.

It is often to be perceived, that in chimneys which are wide only at bottom, the smoke curls down at the sides, and occasionally enters the room; this is caused by the cooling of the external part of the volume, which ought to ascend. And it often occurs that a chimney will smoke on the lighting of a fire in another room; the cause of which is, that, as fire cannot exist without atmospheric air, and the apartments being confined or close, as much air is already absorbed as can be admitted without disturbing the equilibrium; and neither of the fires would burn, but that the vacuum is supplied through one chimney or the other.

Sometimes, a fire will smoke when the door is open, which is owing to the demand for air being great in other parts of the house; the equilibrium is lost, either by exhaustion from other fires, or from other causes. A fire will sometimes smoke into the room, when both window and door are open, by the demand for air being so great in other parts as to draw the whole of what is admitted in a strong draught, and that also which comes down the chimney.

It is seldom that a room will be smoky, when the window alone is open; but if it is, the cause is probably in the stillness and reduced elasticity of the atmosphere, and the consequent slowness of commixture of the outward and inward air. But if in windy weather, it may be owing to the draught having got possession of a defective chimney: or to reverberating winds from higher bodies.

In the chimneys of wind-furnaces, their great length enables them to contain a greater quantity of warm air. For increase of draught, they should not be perpendicularly placed over the fire, but a few feet at the lower part should be built in a direction nearly horizontal.

All chimneys should be smoothly purged when built, to prevent the lodgement of soot, and facilitate cleansing by machines, for no practice can be more barbarous than that of employing climbing-boys.

The best chimneys are those which are of narrow width, and in a direction of considerable inclination; because, by those means, the perpendicular pressure of the atmosphere is reduced, the departing vapour acquires an additional impetus from non-resistance, and the warm air from the room does not so readily escape.

The velocity with which the heated air, passing through the fire, will escape under those circumstances, causes an absorption of that also which is in contact with it. Thus, the action and the consequences are reciprocal; the cool air of the room, drawn into the vortex, blows the fire, and supplies it with its oxygen; and the fire being increased accordingly, so is the absorption of the cold air, and the discharge of that which is heated; and yet the privation of the warm air of the room is not near so great as when a chimney is large, because then, besides what supplies the combustion, the greater draught takes place between the fire and the flue. An aperture at the back of a fire, in a horizontal direction, and communicating with a chimney, would produce this effect more perfectly, because the whole of the draught would pass through the fire, and there deliver its oxygen.

SMUT IN WHEAT.—Dr. Pew, of Sherborne, put in a glass of rain-water 50 smut-balls, which, on the tenth day, exhibited an immense multitude of minute animalculæ, which, on examination with a microscope, proved to be eel-like insects, and very minute creatures, food of the former. The eel-like amounted to about 30, the minute animalculæ, to millions. In a month, Dr. P. witnessed three or four generations of the eel-like insects, and the others were continually regenerating; but some cold nights induced torpor, and, finally, death to both kinds.

Old wheat, infected with smut-balls, produces little or no smut. The very soil becomes infected with the smut-balls, and that though pure and clean wheat be sown, smut on such lands will be produced. Lime, used hot from the kilns, in 200 or 300 bushels per acre, however, effectually destroys the infection, and frees the land from smut.

SNAKE-ROOT, or SERPENTARIA, is a Virginian plant, the root of which, bruised and decocted in boiling-water for two hours, or in powder in doses of 10 or 20 grains, is very efficient in typhus and putrid fevers, and, in ague, in connection with bark. It also improves the action of the stomach.

SNUFFS.—The practice of snuff-taking did not originate with the introduction of tobacco, since we find recipes for making snuff from herbs, &c. in some of the oldest books of medicine extant.

The efficacy consists in promoting a discharge from the head, an effect produced with as great a certainty, and more agreeably, from snuff manufactured from pure tobacco.

The varieties of snuff are almost without number, but, technically speaking, they are divided into two classes only, viz. *Rappee and Scotch*; and the method of manufacturing them in England is as follows:—

The material, varying in quantity for a single batch of any one sort of snuff, from 2 cwt. to 20,000 lbs. is first spread on the floor, when it is copiously sprinkled with what is termed the *cure*, being a liquid preparation, in which about 2 per cent. of salt ought to form the principal ingredient; but, as every manufacturer has a different mode of laying down snuffs, various flavours are often introduced. It is then heaped into a bin, where it is suffered to remain until it has gone through a thorough heat. The fermentation which comes on so great a mass of vegetable substance, is frequently too hot to be borne by the hand for any length of time. By this process, the tobacco is deprived of much of its essential oil, in which consists its unwholesome and intoxicating properties, and it is rendered at the same time more mellow, and less likely to ferment after it is ground, which would turn the snuff musty.

After having been thoroughly heated, the snuff-work is turned out of the bin, and suffered to cool. It is then sent to the mills, and ground to whatever grain the manufacturer chooses to direct. This is the English method.

The prejudices in favour of foreign snuff are not without substantial foundation; since, owing to the excessive duty on tobacco, (amounting generally to between 600 and 900 per cent.,) the English manufacturer cannot afford to allow his raw material to lie any considerable time in process of manufacture; but foreigners, in consequence of not having to struggle against a large capital lying dead, can allow the snuff-work to remain in process frequently for two or four years. Their method is (after having cured their tobacco,) to spin it into what is termed *carotte*, consisting of long rolls of tobacco, varying in weight from 5 to 10 lbs. These are piled up in immense numbers, and undergo a gradual and almost imperceptible fermentation, instead of the violent and rapid heat into which the English manufacturer is required to force his material, and, consequently, a mellowness and flavour results, superior to that acquired by our method.

Foreign makers have also a superior method of reducing the article into snuff. Instead of grinding it under ponderous stones, they either cut it into grain with peculiar machinery, or rasp it by a circular file, thereby entirely avoiding the great friction by which English snuffs are so much deteriorated, as even to interfere with delicacy of flavour.

The superior sorts of snuffs are manufactured from pure leaf-tobacco, the growth of various countries, and selected according to the sort that is required. The inferior descriptions are made from what is termed the offal, or smalls, which fall out of the tobacco, after it is manufactured for the purposes of smoking and chewing. Now, as it is impossible to produce a large flaky grain from the latter material, it follows, that coarse snuffs always belong to the first class, although a fine-grained snuff may also be made from first-rate material. The best security however that the consumer can have, is to make his purchases at respectable houses, which keep immense stocks, and are enabled to offer snuffs, old, as well as good in quality, for age in snuff is quite as essential as in wine.

There is a ridiculous error prevalent, that snuff is adulterated with ground-glass, and it arises from the sand which gathers on the tobacco-leaf while growing, and which sand, when dry and pulverized, glitters in the snuff, and is mistaken for glass. It is, however, a good maxim to avoid cheap snuffs; for whatever impurities exist in tobacco, are sure to find their way through the sieves employed in sifting the offal, the worst portion of which, of course, is employed in the cheapest article.

The total revenue derived from tobacco and snuff amounts to upwards of three millions, about 70,000*l.* of which is derived from the importation of foreign segars, which pay 9*s.* per lb. duty, and the actual consumption of which last year, independently of the immense quantity of those made in England, was upwards of 140,000 lbs.

Upwards of 100 sorts and varied scents are constantly on sale at Taylor's, in Fleet-street, and in other fashionable London snuff-shops. Latterly, snuff has been prescribed for all cases in which there is a tendency of blood to the head, and to apoplexy; the increased secretion being deemed beneficial. At the same time, an increased excitement in such near connection with the intellectual organs, serves to promote vigour of thought, in pursuits which draw largely on the mind.

SOAP, is the union of fat oils and water, by means of an alkali, to which both unite.

Oils, or fats, which saponify the best, are:—1. Oil of olives, and of sweet almonds; 2. Palm-oil; 3. Animal oils, as hog's lard, tallow, butter, and horse oil; 4. Oil of colza, or rape-seed-oil; 5. Oil of beech-mast and poppy-seed, mixed with olive-oil, or tallow; 6. Fish-oils; 7. Hemp-seed-oil; 8. Nut-oil and linseed-oil; 9. Rosin. In general, soaps are those of olive-oil, palm-oil, tallow, lard, and rosin. Soap, formed by the union of bees'-wax with alkali, is used only for painting in encaustic.

Soap consists of 60·94 oil, 8·56 soda, and 30·5 water. Salt is an ingredient of all hard soap. Alcohol dissolves it, and then, if evaporated, the residuum is *transparent* soap. Soft soap is made by a ley of potash, and hard of a ley of soda.

Soaps afford acids, as *steartic*, when mutton fat is employed; *magaric*, when olive-oil; *oleaic*, when linseed-oil, &c.

Solution in water is instantly disturbed by acids, which, seizing the alkali, either separate the fatty principles, or unite with them in a soapy, acidulous *emulsion*. Solution in water is likewise decomposed by almost all the earthy and metallic salts, which give rise to insoluble compounds of the oleaic and margaric acids, with the salifiable bases.

Marseilles white soap is composed of soda 6; oil 60; water 34.

Castile soap is soda 9; oily matter 76·5; water, with colouring, 14·5. The art of soap-making consists principally in knowing how to determine, from the appearance of the paste, and other circumstances, what kind of lixivium should be employed during each step of the operation.

Soap curdles in all water that contains earthy salts, as sulphate of lime, and, hence, called hard water; the alkali of the soap leaves the oil, and combines with the acid of the salt, or acid of the sulphate, and the oil and earth then form flakes or curds. The remedy is a sufficient dose of soda, which neutralizes the acid in the salts, and prevents their acid decomposing the soap. As all spring and river water has more or less of these earthy salts, so washerwomen ought to combine so much soda in the water as affords a good lather.

It is the same with sea-water, for the muriate or acid in the salt instantly unites with the alkali in the soap, and, to soften sea-water, it is necessary to add clay to the soda and grind them to a paste, a pound of which in four gallons of sea-water will protect the soap, and when settled, or filtered, enable it to form a good lather for washing.

As animal fats are very nasty substances in soap, it is necessary to buy of soap-makers who make of palm, or cocoa-nut-oil, which is largely imported, both for soap and candles.

*To make hard soap.*—A ley of potash, rendered caustic by quicklime, is used in the saponification, and to the soft soap, which results, is added common salt, or a kelp ley, which supplies abundance of salt, or muriate of soda. The muriatic acid goes to the potash, to form muriate of potash, which dissolves in the water, and is drawn off in the spent ley. The soda enters into combination with the fat, and forms soap, which, on cooling, becomes solid. Two tons of palm-oil, or tallow, should yield three tons of marketable white soap.

*To make soft soaps.*—The compounds of oils or fats with potash remain soft, or at least pasty, as soaps from oleaginous seeds, called *green soaps*; *toilet soaps*, made with hog's-lard; and *common soft soap*, made with palm-oil or animal fat. The art consists in effecting the combination of the oil with the potash, without the soap *ceasing* to be dissolved in the ley; while in the fabrication of hard soap, it is necessary to *separate* the soap from the ley, even before the saturation of the oil is accomplished. Soft soap may readily be converted into hard soap by the addition of common salt. Cheap *toilet* soaps are made with palm-oil, hog's-lard, and potash, and have as small an alkaline excess as possible; but fine soaps for the toilet are made with palm-oil, oil of almonds, or nut-oil.

*Compound liniment of soap*, is hard soap 3, camphor 1, spirit of resemary 16, sometimes with laudanum. This is opodeldoc. Steers' is Castile soap 1 oz. spirit 8 oz. Oils of rosemary and organum, and solution of ammonia 6 drs. Bates' anodyne balsam, Freeman's bathing spirits, Jackson's bathing spirits, &c. are all on the same principle.

SOAP-BERRY TREE, produces fruit used with rum, as an embrocation in rheumatism. The tops, leaves, and seed-vessels, form a lather with water, and cleanse linen, &c. The plant intoxicates and kills fish.

SODA, formerly called the *mineral alkali*, because, as *natron*, it is found native. It is now usually obtained from the incineration of marine vegetables. The various kinds of *fuci* afford the impure alkaline product known in commerce by the name of *kelp*, and the genera *salsola* and *salicornia*, in particular, furnish the pure *barilla*. The soda is combined with carbonic acid, and with muriate and sulphate of soda, charcoal, lime, magnesia, silica, and alumine.

At Alicant, the *salsola soda* marine plants are burnt with just heat enough for semi-fusion, when it concretes in cellular masses. In Sicily, is burnt before quite dry, and the soda is then better.

The origin of the soda is undoubtedly from the salt, or muriate of soda, with which such plants are supplied from their situation; since, when transplanted to inland situations, they cease to yield soda, and only afford potash.

Barilla, in powder, being lixiviated with boiling water, the solution, on evaporation, affords crystals of *carbonate* of soda, and, to remove the acid, the same process is employed as in procuring potash; *i. e.* the salt is dissolved in twice its weight of water, and filtered through slacked lime. The lime abstracts its carbonic acid, but to obtain the soda perfectly pure as a solid white mass, it must be submitted to the action of alcohol. In its driest state it is a hydrate, consisting of soda 32, water 9. Soda is possessed of all the alkaline, or anti-acid properties in common with potash. It changes the vegetable colours to green, but does not act so powerfully on the metals, or the earths, as potash. It combines with earths by fusion, and forms, with silica, very perfect glass.

By concentrating its alkalinity, or driving off all its acid from the carbonate, by the energy of the galvanic poles, it becomes pure alkali and carbon, sp. gr. 6·972, called *sodium*, and, as such, cannot subsist in air, from which it re-absorbs 1-3rd oxygen, and returns to carbonate of soda, (as sodium 3, oxygen 1,) as which it can subsist in the medium of air, 1 oxygen and 3·5 nitrogen. In like manner, sodium decomposes water, absorbing the oxygen and setting the hydrogen free as gas. It performs all the functions of pure alkali, or fixed nitrogen, and as such illustrates all the play of alkali and acid, which produce so many phenomena. It burns in hot water, by fixing oxygen, and returns to carbonate of soda. In oxymuriatic gas, called chlorine, sodium also burns by fixing the extra dose of oxygen, and returns to its original, common salt; and with other combinations might then be returned to its original barilla. By some properties it has been called *a metal*, and, hence, it would appear that all metals are mainly alkali and carbon, formed by expelling the oxygen, &c. from the ores, so as to retain sufficient oxygen to subsist in air, but oxydizing when less than 1 oxygen, to 3·5 alkali, as in lead, iron, and manganese. Salt appears to be carbon and oxygen with hydrogen, (a form of nitrogen) derived from water. Carbonate of soda is carbon, oxygen, and nitrogen; and sodium is carbon and nitrogen. Carbonate of soda has, in fact, the constituents of prussic acid, but in different proportions.

*Common salt*, or *muriate of soda*, by the drying of salt lakes, or by the perihelion inundations of the sea into cavities, is accumulated in vast beds in the bowels of the earth, whence it is quarried under the name of *rock salt*; and sea-water contains about 3·5 per cent. of it, from which it is easily procured by evaporation. Sea-salt is, however, impregnated with magnesia, and rock-salt, as it comes from the mine, sometimes requires to be dissolved and evaporated, in order to free it from the oxide of iron and clay, with which it is often blended. Common salt, in its state of greatest purity, has the following properties:—It is white; crystallizes in cubes; has a sp. gr. of 2·12 to 2·25, and 100 parts of water at 57° dissolve 36 of salt.

at 140° ...... 37 do.
at 229½ ...... 40·38 do.

When heated, it decrepitates, or cracks, and at a red-heat melts into a liquid without undergoing decomposition. In a high temperature, it may be sublimed. It contains no water of crystallization.

*Sulphate of soda* was discovered by Glauber, and known under the name of *Glauber's salt*. It may be procured by saturating soda with sulphuric acid, but is more usually obtained by decomposing common salt with sulphuric acid. As a purgative, the use of this salt is very general; and it has been employed to furnish soda. It has been employed also in glass-making: equal parts of carbonate of lime, sand, and dried sulphate of soda, produce clear, solid, pale-yellow glass. *Bisulphate of soda* may be obtained by dissolving sulphate of soda in dilute sulphuric acid, and, after concentrating it sufficiently, setting it aside. It is twice as soluble as Glauber's salt.

*Nitrate of soda* is obtained by adding dilute nitric acid to soda, or by mixing nitrate of lime and sulphate of soda together, filtering the solution and evaporating, and is sometimes used in fire-works, on account of its communicating a fine orange colour to combustibles while burning.

Large quantities of *carbonate of soda* are manufactured from common salt; and it may now be obtained at one-third of its former cost; and it is also taking the place of potash in all manufactures that require an alkali. Convert common salt into sulphate of soda by means of sulphuric acid, and heat the sulphate of soda with sawdust, or small dross of pit-coal, by which it is converted into sulphuret of sodium. By means of lime, or roasting the sulphuret, the sulphur is gradually dissipated, and the sodium converted into *carbonate of soda*. Two successive crystallizations, in open iron coolers, produce beautiful crystals of carbonate of soda. Its constituents are: carbonic acid, 2·75; soda, 4; water, 11·25.

*Bicarbonate of soda* is obtained with ease by suspending a solution of common carbonate of soda over a brewer's fermenting tun during the fermentation of beer.

*Phosphate of soda* is prepared by saturating phosphoric acid (obtained from burned bones) with carbonate of soda, and setting the concentrated solution aside to crystallize. It is much used as a purgative, and is not distinguishable from common salt.

Borax is brought from the East Indies in an impure state, under the name of *tinkal*, enveloped in a kind of fatty matter, now known to be soap, with *soda* for its base. It consists of boracic acid 6; soda 4; water 9. It was formerly employed in medicine as a sedative, and is still used to form a gargle; but its great utility consists in its application as a flux in soldering, and in the fusion of silicious stones for the formation of pastes, or artificial gems, and for the glazing of pottery.

Soda combines with animal substances and secretions, but no portion of potash; hence, the latter is more operative as a medicine.

*Soda powders*, consisting of half a dr. of carbonate of soda, and 25 grs. of tartaric acid, form tartrate of soda; while soda-water is an acid solution of carbonate of soda.

*Soda-water* is a solution of a dr. of carbonate of soda in a pint of water, and then carbonic acid gas is passed through it, till the acid is in excess. The gas is best formed by adding dilute (6 water) muriatic acid to white marble.

Bakewell, of Hampstead, has patented improvements in machinery, or apparatus for making or manufacturing soda-water, or other aerated waters or liquids.

The apparatus consists of an external casing of a cylindrical form, with spherical ends, made strong enough to resist a pressure of several atmospheres. There is a partition about two-thirds from the top of the vessel. The bottom part is a receptacle for the chalk, or other suitable material, and water from which the carbonic acid gas is to be generated; then there is a vessel containing diluted sulphuric or muriatic acid, which passes out in small quantities, as required, into the vessel. When the chalk and acid receptacles are to be supplied with those ingredients, the apparatus is to be turned on its pivots to a horizontal position. The apparatus is then to be put into vibration on pivots, by which the chalk and water will be effectively agitated by the motion of a pendulum, while a small portion of acid will escape to keep up the generation of the gas as it passes off to the water, which will, at the same time, by the vibration of the apparatus, be thoroughly mixed with the gas as it escapes into the water.

*Super-carbonate of soda-water* is made by dissolving 2 oz. of subcarbonate in 5 quarts of water, and infusing by pressure carbonic acid gas, made by gradually mixing equal parts of carbonate of lime and sulphuric acid in 12 times their weight of water.

SOILS.--In affording warmth, the power of accumulating and retaining it varies as much in soils as the proportions of their constituents. A rich black mould, containing one-fourth of vegetable matter, has its temperature increased, in an hour, from sixty-five to eighty-eight degrees, by exposure to the sunshine; while chalk soil is heated only to sixty-nine degrees; but the first, in the shade, cools, in half an hour, *fifteen* degrees, whereas the latter loses only *four* degrees. The colour of a soil also influences the accumulation of heat. Black coal ashes, sprinkled over the surfaces of beds sown with peas, beans, &c. cause the plants to appear above ground two or three days earlier, on account of the increased warmth.

SOLDER. For the simple solders, each of the metals may be used, according to the nature of that which is to be soldered. For fine steel, copper, and brass work, gold and silver may be employed. In the large way, however, iron is soldered with copper, and copper and brass with tin. The most usual solders are the compound, which are distinguished into two principal classes, viz.: hard and soft solders. The hard solders are ductile, will bear hammering, and are commonly prepared of the same metal with that which is to be soldered, with the addition of some other, by which a greater degree of fusibility is obtained.

The hard solder for *gold* is prepared from gold and silver, or gold and copper, or gold, silver, and copper.

The hard solder for *silver* is prepared from equal parts of silver and brass, but made easier of fusion by one-sixteenth of zinc.

The hard solder for brass is obtained from *brass*, mixed with a sixth, or an eighth, or even one half of zinc, which may also be used for the hard solder of copper. It is sold in a granulated form, under the name of *spelter solder*.

The soft solders melt easily, but are brittle, and cannot be hammered. Of this kind are the following mixtures:—tin and lead, in equal parts; of still easier fusion is that consisting of bismuth, tin, and lead, in equal parts; one or two parts of bismuth, of tin, and lead, each one part.

In the operation of soldering, the surfaces of the metal intended to be joined must be made very clean, and applied to each other, and it is usual to secure them by a ligature of iron wire. The solder is laid upon the joint, together with sal-ammoniac and borax, or common glass, according to the degrees of heat intended, and these additions defend the metal from oxidation.

Glaziers use resin; and pitch is sometimes employed.

Tin foil, applied between the joints of fine brass work, first moistened with a strong solution of sal-ammoniac, makes an excellent juncture, care being taken to avoid too much heat.

SOLVENTS. Alcohol and water dissolve sulphur, fixed alkalies, tannin, solid acids, most salts, phosphorus, soaps, &c.

SOLUTION OF BURNT SUGAR. *To determine the discolouring power of charcoal.*—In a vessel burn white sugar, till to the sides adheres a blackish brown substance, which form into a mixture with a liquid of water 8 parts and alcohol 3 parts. Use in small quantities, much diluted with water, for exhibiting the shade of colour.

SOCIETIES, are admirable institutions, during one generation of original members, for stimulating the mutual exertions in the promotion of various objects; but, owing to fundamental errors in providing for renewals of members, and for future management, they fail, even in the second generation, in vigour and utility; while, in a third or fourth, they become discouragers of all originality and enterprise. A few ardent persons form the first association, and to secure a monopoly of its expected advantages, provide that no member shall be admitted who is disagreeable to some small minority, often only two or three. This is fatal, for eminence within is always jealous of eminence without; and the orthodoxy within is tenaciously opposed to the originality without. Hence, the society soon represents only the talent of some previous generation, and, as far as it has weight or influence with the vulgar, obstructs by its exclusion all contemporary talent, and by system all aspiring originality. It starts with ten workers for one drone; in the third generation, it has ten drones for one worker; in the fourth, one hundred to one; and, in the fifth, two hundred to one; till, instead of being any advantage, it becomes the mere stalking-horse of pride and vanity. Nor is this a picture of any one society, but of nearly all, for the same principle of deterioration, or breeding in and in, is common to all. The remedy is plain; nothing but a high majority should exclude, as three to two, or three to one, and elections should be probationary for a year, subject to be set aside on the call of a high fraction of the society. Nor ought it to be required, that men of genius should be obliged to intrigue as candidates, but at every vacancy two or three members, in rotation, should be at liberty to nominate such persons, as their own spontaneous act. Every ten years there ought, also, to be such a purgation of drones as should constantly render the contemporary majority a race of workers. Societies, so constituted, would be illustrious by deeds as well as by name.

SOUND IN WATER. Experiments on the velocity of sound in water have been made on the Lake of Geneva, and are connected with researches on the compressibility of fluids. The space through which the sound passed was about 45,000 feet (13,487 metres.) The sound was produced by striking a large bell suspended in the water, and was heard by means of a peculiar apparatus, so constructed that the person who listened for it could also observe the signal at the bell, and both set going and stop the time-piece. The mean of several experiments was 9·4 seconds, for the whole distance: on dividing the distance by the time, the velocity of sound on the water of this lake was 1435 metres, or 4708 feet per second.

SPACE, abstractedly considered, is mere extension, or triple dimensions; but, in fact, it appears to be the base of matter, and, owing to the mobility of the latter, space and matter must be co-extensive; since matter, in moving to parts which present the least resistance, must necessarily be present, actually or potentially, in all space. But this plenum is not a plenum of matter, but of matter in motion, or in power. The fixity of space reduces all motion to the action and reaction of matter; and, when action in a dense body does not find similar materials for its transfer, the fixity of space renders the smallest material atoms patients of the action; and, hence, arise many phenomena. The investigation does not, however, properly belong to this work.

SPADE-HUSBANDRY, or manual digging instead of ploughing with horses, seems to be the necessary resort of the British people, reduced to a primitive industry by the ignorant policy of the state. A spade is a cheap tool, and it corresponds with the existing capital of the mass of our once opulent cultivators. A man can dig, dress, and set out in an acre-spade, deep, all that is necessary, in 12 days; and in heavy soils, with some attention to draining and weeding, in 15 days, which by the plough would cost from 14*s.* to 18*s.* while the object would in all respects be much better effected. As a family would have superabundance in the produce of an acre and a half of good soil, and two and a half of poor soil, there is, of course, sufficient in our 56 millions of acres for 28 millions of families, with far greater comfort than is now enjoyed by 3 millions out of the 4 under the existing system of monopoly and exaction. The spade is the tool which with the mattock effects the process of trenching, or inverting the soil for 18 or 20 inches, by which the worst lands in the kingdom might be made productive. A cottager having obtained 3 acres, at the rent of 3*l.* per acre, lately showed what could be done with the spade. On half an acre he produced 240 bushels of potatoes, on a quarter 60 of carrots, on a three-quarter piece five quarters of oats, on 1 acre 4 loads of clover, on an 8th turnips worth 1*l.*—Besides peas, beans, onions, &c. on three-eighths for his family, the market value of all which was above 54*l.* The rent being so high as 9*l.* the seed &c. was 3*l.* so that he cleared 42*l.* or 16*s.* 4*d.* per week for labour. The same good effect arises from a *generous* clergyman near Bath letting some small patches at 10*l.* an acre, but, in spite of this extortion, the poor people make it answer. In fact, in a formal experiment recorded by Sir John Sinclair, it appears that, in the same field, spade produce was to the best plough produce as 55 to 42. That eminent man thinks that all small farms, where horses cannot be kept, the business would be economized by the spade.

The plough cuts a *slice* of land, and turns it over, leaving the part turned over smooth, also the bottom over which the lower part of the plough has been made to slide, smooth too, and well trodden down besides by the feet of the horses. This slice of land may be five, or at the most six, inches in thickness, and however well and carefully it may afterwards be worked, by means of cross-ploughing, harrowing and rolling, *yet six inches is still the limit of the cultivation of the soil.* But the spade goes to the depth of nearly twelve inches, and leaves the soil *broken at the bottom* ; the air obtains access to this, fermentation in consequence commences, and an immediate step towards fertility is made. Compare the state of a cottage garden, which has been under decent cultivation for some years, with the state of the farmer's land on all sides of it, divided only by a hedge. Let the cottager use his spade, and the farmer his plough, and the superior quality and greater richness of the cottage garden will be evident, and this improved quality is owing more to *cultivation* than to *manure*, for in many instances the farmer uses more manure than the cottager, and yet, for want of *deeper cultivation*, his land does not receive proportionate improvement.

SPANISH LIQUORICE, or Pontifract Cakes, are made by boiling 1 ℔. of sliced liquorice-root in a gallon of water. Then macerate for 24 hours, and boil down to half. Strain and evaporate to hardness. The impure liquorice, brought in cakes or rolls from Spain, is purified by dissolving, straining, and evaporating. In Spain, in the large way an oil-mill is used, and the juice boiled.

SPECIFIC GRAVITY, is the relative density of a body to water usually reckoned 1. And a cubic foot weighs 1,000 ounces.

To determine the specific gravity of a body, weigh it in water and out of it, and then divide the weight out of water by the loss in water, and the quotient is the specific gravity to 1 ; and by 1,000 is the oz. in a cubic foot.

To determine the specific gravity of a body lighter than water, join it to a heavy body whose weight in and out of water is known.

Specific gravities, in a popular way, are determined by simply weighing bulks. Thus, if we want a fluid of 0·8, five measures of it is equal to 4 of water, for $5 \times 0{\cdot}8 = 4$, and $4 \times 1 = 4$. Or a body equal to 1·5, 2 measures of it is equal to 3 of water, for $2 \times 1{\cdot}5 = 3$, and $3 \times 1 = 3$. Or, conversly, if we have a fluid, 6 measures of which is equal to 5 of water, the specific gravity is 5-6ths, $= 0{\cdot}833$.

Specific gravities may be determined by weighing equal bulks in common scales, very near the truth. Thus a phial, filled with 100 grains of distilled water, may be marked and filled to the same mark with alcohol ; when the weight will be 79·80, being the true specific gravity.—*Mechanic's Mag.*

In relation to air, of which 100 cubic inches weigh 30·519 grains, and which is to water as 0·00120855 to 1, hydrogen is 0·0694, or weighs but 2.118 grains. Steam of water is 0·481. Nitrogen, carbonous oxide, and carburetted hydrogen, are 0·9722 ; oxygen, 1·1111 ; muriatic-acid gas, 1·284 ; carbonic-acid gas, 1·5277 ; cyanogen, 1·8055 : chlorine, or oxymuriatic acid, 2·508 ; and chloric acid gas, 5·277.

Taking water as 1, and to air as 827·437 to 1, commonly 820 to 1 ; sulphuric ether is to water as 0·727 to 1 ; naphtha, 0·708 ; alcohol, 0·803 ; spirits of wine, 0·84 ; proof spirit, 0·93 ; brandy, 0·8371 ; oil of turpentine, 0·86, or 0·792 ; linseed-oil, 0·94 ; olive-oil, 0·915 ; sal ammoniac, 1·078 ; sulphuric acid, 1·84, and 2·125 ; nitric acid, 1·58 ; muriatic acid, 1·194 ; fluoric acid, 1·5 ; acetic acid, 1.063 ; distilled vinegar, 1·005 ; tallow, 0·9419 ; bees'-wax, 0·9648 ; white sugar, 1·606 ; oil of cloves, 1·034 ; charcoal, 2 ; alum, 1·033 ; lime, 2·39 ; soda, 1·336 ; potash, 1·708 ; magnesia, 0·346 ; barytes, 4 ; rosin, 1·0772 ; honey, 1·45 ; gum arabic, 1·515. The specific gravity of ammonia varies from 0·875 to 0·969 ; and at the former it is, ammonia, 32·5, and water, 67·5 ; at the latter, 9·5 and 90·5.

When there is no water in alcohol, the specific gravity is 0·7946. The specific gravity of its vapour is 1·6. Its boiling point varies with its density from 173 to 196. Combustion converts it into water and carbonic acid gas.

The specific gravity of any solid is determined by weighing it in air and in pure water, and the weight in air, divided by the *loss* in water, is the specific gravity as to water.

The specific gravity of any fluid is determined by dividing the grains lost in the fluid, by the grains lost in water ; or, taking water as 10 lbs. we get the weight of a cubic foot of the other in lbs.

*Specific Gravity of Metals and other Bodies to Distilled Water, and the Weight of a Cubic Inch in Ounces.*

| Bodies. | Sp. Grav. | Oz. Av. |
|---|---|---|
| Pure gold cast | 19258 | 71036 |
| ——— hammered | 19362 | 70030 |
| Standard gold cast | 17486 | 63250 |
| ——— hammered | 17589 | 63618 |
| Pure silver cast | 10474 | 37796 |
| ——— hammered | 10511 | 38017 |
| ——— silver in coin | 10391 | 37580 |
| Platina purified | 19500 | 70530 |
| ——— hammered | 20377 | 73557 |
| Mercury | 13568 | 49074 |
| Lead fused | 11352 | 40966 |
| Copper fused | 7788 | 28168 |
| ——— in wire | 8878 | 32111 |
| Brass cast | 8396 | 30367 |
| ——— in wire | 8544 | 30903 |
| Iron cast | 7207 | 26067 |
| ——— bar | 7788 | 28168 |
| Steel, soft | 7840 | 28356 |
| ——— hardened | 7816 | 28270 |
| Tin, fused | 7291 | 26371 |
| ——— hammered | 7299 | 26400 |
| Bismuth | 9823 | 35529 |
| Nickel | 8660 | 31323 |
| Arsenic | 5763 | 20844 |
| Cobalt | 7812 | 28255 |
| Zinc | 7191 | 26009 |
| Antimony | 6702 | 24240 |
| Manganese | 6850 | 24776 |
| Diamond | 3251 | 11759 |
| Ruby | 4283 | 15491 |
| Topaz, oriental | 4011 | 14507 |
| ——— Brazilian | 3536 | 11718 |
| Sapphire, oriental | 3994 | 14446 |
| Emerald | 2775 | 10037 |
| Adamantine spar | 4180 | 15118 |
| Quartz | 2654 | 09599 |
| Agate | 2590 | 09368 |
| Onyx | 2376 | 09537 |
| Muscovy talc | 2792 | 10098 |
| Common slate | 2672 | 09664 |
| Calcareous spar | 2715 | 09820 |
| Alabaster | 2730 | 09874 |
| White marble | 2716 | 09823 |
| Limestones, from | 1386 | 05113 |
| ——— to | 2390 | 08644 |
| Ponderous spar | 4474 | 16182 |
| Fluor spar | 3180 | 11502 |
| Pumice-stone | 914 | 03306 |
| Green glass | 2620 | 09476 |
| Crown glass | 2520 | 09115 |
| Flint glass | 3290 | 11900 |
| Brimstone | 1990 | 07198 |
| Phosphorus | 1714 | 06199 |
| Yellow amber | 1078 | 03899 |
| Sea-water | 1026 | 03711 |

SPELTER, or WHITE VITRIOL.—Quench roasted silver ores in troughs of water, then evaporate this water, and set it by to crystallize. Melt the crystals, skim the impurities, and pour the melted mass into wooden boxes, disturbing the crystallization by stirring. It is used as a drier of oil-paint.

SPERMACETI OINTMENT, is made of 3 spermaceti, 1 white wax, with olive-oil, to consistency, at a gentle heat; or 1 white wax, 2 spermaceti, and 6 lard.

SPIDER WORT.—Leaves, flowers, seeds, used against bites of scorpions: roots similar to squills.

SPILSBURY'S ANTISCORBUTIC DROPS.—Alcohol and water, of each 8 ounces; in which are infused 2 drams each of orange-peel, gentian-root, and corrosive sublimate, with 1 dram each of red sanders-wood, and crude antimony. *Or*, sulphuric acid 1 ounce, spring-water 4 pints, gentian-root 4 ounces, cochineal 5 drams and 1 scruple, 10 drams and 2 scruples of tartarized antimony, and 4 scruples of corrosive sublimate.

SPINACH, has emollient leaves, and opening, when boiled as greens.

SPINE.—The vertebral or spinal column, or back-bone; the articulated bony pillar at the back of the trunk. It is placed perpendicularly in the body, supporting the head on its upper extremity, while the lower end rests on the pelvis. It is the point of attachment and support in front, for the viscera of the thorax and abdomen, and for the great trunks of the blood-vessels. Further, it constitutes a canal, which receives and protects the spinal marrow, and gives issue to the various nerves proceeding from that organ to the trunk and limbs. It is formed of twenty-nine pieces of bone, strongly articulated into each other, and placed in succession from above downwards, and the twenty-four upper ones are called *vertebræ*.

The beauty of the whole body depends chiefly upon the natural formation of the spine. This column of vertebræ ought not permanently to deviate from the straight line to the right or left; but it has naturally some slight curvatures forwards and backwards. If the vertebræ themselves suffer from disease, as, for instance, in case of rickets, the spine is not capable of supporting the head and keeping the body straight; it becomes curved, and, if remedies are not applied, this unnatural curvature increases daily, and permanent distortion at length takes place. Mechanical support, by an apparatus resting on the shoulders, cold bathing, friction, and tonics, are the remedies.

SPINNING, or converting fibrous materials into threads for weaving, is one of the most important and extensive employments. The distaff was the first machine, and the thumb and finger the tools, with saliva for cement. These operations have, however, been imitated, 1st, by Hargreave, in his jenny, which drew out and twisted a dozen threads. 2d, by Arkwright, with his rollers of different velocity, in which he exactly imitated the action of the thumb and finger. And 3d, by Crompton, in his mules, by which he spins from 100 to 1000 threads. The same machinery is extended to cotton, flax, wool, silk, &c. and competition has raised factories, which, in bulk, are wonders of the world, by which the labour of twenty or thirty women at the distaff are now performed, in general better, by single children. Patents out of number have been taken, to improve, simplify, cheapen, and accelerate. These apply, however, to the finer fibres; but Long has recently applied the same principles to coarse hemp, by larger and stronger machinery.

The hemp is distributed on the endless leather of a spreading-table, by which it is conveyed to the feeding rollers, and by them delivered upon the gill, or needles, by the operation of which the fibres are drawn out and laid lengthways into a band of hemp of uniform width and thickness. The gill consists of a series of arms, projecting from an endless band, passing about two rollers, with indentations so arranged, that the ends of the arms next the chain fall successively into them, and cause the points or needles, projecting from other ends of the arms, to penetrate into the hemp, and to draw it out from the feeding rollers: and, when the needles have drawn the hemp, and carried it the length of the gill, they are withdrawn by their passing over the second notched roller, while the hemp is delivered to the pressing roller. The difference between this and the common flax gill consists in an adjustment, by which the distance between the feeding-rollers and the gill, as well as the extent of the drawing operation of the gill, can be regulated to correspond with the length of fibres to be operated upon. Another improvement is, the introduction, at pleasure, of an additional pair of drawing-rollers, with an adjustable gearing to give them motion, when the length of the fibre requires such an addition.

The other parts of the process of spinning cords for rope-makers do not differ materially from the usual operation of spinning flax, except the introduction of a series of folds of strong felt, through which the strand is drawn after it passes the conical condensing tube; the intention of which is to press down and cause to be mixed into the strand the ends of the fibres.

After all, the distaff-spinning of the Hindoos exceeds, in fineness, any product of machinery, and their shawls, silks, and muslins, are miracles of human art.—*See* Cotton, Silk, Flax, &c.

SPIRITS.—These are generally, in England, produced from 3 parts of raw grain to 1 of barley malt. Raw barley produces less spirit than raw wheat, and rye more than either. In Scotland the proportions are 1 malt to 5 or 6 raw.

It is coarsely ground, or broken, some cold water added, then water 90°, and yeast. The temperature should be about 70, and neither be so high as 77, nor so low as 60. The fermentation is continued till the wash is clear, about 3 days. It is then well stirred, put in the still, and stirred till it boils.—*See* Distillation.

It will produce 20 gallons of spirit from 100 of wash. If cyder wash, but 15; and if molasses, 22. The best French wines yield 18 to 22 of brandy. British wines, stopt in fermentation, yield but 14 or 16.

Ninety quarters of grain ought to produce 9720 gallons of wash, and 1623 gallons of spirit, from 1 to 10 over proof. *i. e.* 3 barrels, or 108 gallons of wash and 18 of spirit to the quarter from 1 to 10. 1 cwt. of sugar yields 100 gallons of wash, and 21 or 22 of spirits, and the temperature is 20° higher than in the corn fermentation. 2 of water is added to 1 of molasses, but in Ireland 3 of water. One of yeast is added to 200 or 300, and stir with a birch-broom. In 3 or 4 days the water is doubled, and at 90° the yeast repeated. In 5 or 6 days, an ounce of powdered jalap to every 1000 lbs. of molasses, and the same yeast must be repeated. In 3 or 4 days, when the fermentation abates, it is turned into the still and distilled 4 times. The still-house should be kept at 60° or 62°.

The fiscal regulations, the locks, visitations, the arbitrary rules, &c. &c. under which these processes are performed, are subjects for historical anecdote, if, in other ages, or countries, they can be credited. The same system follows the rectifier, and improvements and varieties are impracticable.

The strength of spirits, in a current manner, is determined by the blebs or bubbles in a shaken phial; they last as the strength is less, and go off as the strength increases. The hydrometer is the accurate measure, but dealers know at sight the degrees, by the quantity and endurance of the bubbles.

Rectified spirits are fined for immediate use, by a small quantity of powdered alum.

Three gallons of proof spirits yield but two of rectified, and for double goods a gallon of liquor is added, but for single goods one gallon and a half is added.

Mr. Gutteridge lately published an improved plan for assaying spirituous liquors, by weight, per gallon, since *above* 62° all spirits *expand*, and *below* 62° *contract*, so that measure and hydrometer are not tests of quantity except at 62°. Hence, the charge of duty is *greater* than the quality per cent. for all temperatures less than 62°, and the charge per cent. is less than the quality per cent. for all temperatures above 62°. In other words, the charge is too little for all heats below 62°, and too much for all above. In fact, a gallon measure at 62° would flow over, if the heat of the weather rose above 62°, but it would cease to be full if the thermometer were less than 62°. The extreme difference is 4 per cent. The standard, therefore, is weight, and this alone ought to determine duties.

Mr. G. has, therefore, produced a very elaborate set of tables, in which he reduces all strengths, per Sikes, to the proper quantum at 62°, and shows their true quantities at every degree of temperature, from 30° to 80°, in relation to the standard quantity at 62°, on which duty is charged. As the quantity increases the value diminishes; and, hence, temperature which varies quantity cannot be neglected.

To facilitate estimates by weight, Mr. G. has made a new hydrometer, for determining the pounds per gallon, for all fluids heavier than water, as worts, or lighter, as spirits, and this is an undoubted acquisition. He impeaches Sikes's hydrometer, as an insult to science, and gives decided preference to that of Dicas and Ashton.

According to Brande, Scotch whiskey contains 54·32 of spirit, Irish 53·9, rum 53·68, brandy 53·39, gin 51·6.

Spirits rectified have a specific gravity of 835, and proof spirit of 930, so that in strength 9 of the former is nearly equal to 10 of the latter.

*Spirits from berries of Mountain-ash.* The berries, when perfectly ripe and dry, are put into a wooden vessel, bruised, and boiling water poured on, the whole being stirred until it has sunk to 82°. A proper quantity of yeast is then added, and the whole covered up, and left to ferment. When the fermentation is over, the liquor is to be put into the still, and drawn over in the usual way. The first running is weak and disagreeable in flavour; but being distilled from off very fresh finely-powdered charcoal, in the proportion of 8 or 9 lbs. to 40 gallons of weak spirit, a very fine product is obtained. The charcoal should remain in the liquid two or three days before the second distillation.

*Spirit of Menderirus*, is made by combining 1 oz. of sub-carbonate of ammonia with a pint of distilled vinegar, but the proportions must accord with the strength of the two articles. It is used as a diuretic, eye-water, lotion for bruises, &c.

*Spirit of Soap.*—In 8 pints of alcohol mix half an oz. of gum benjamin, 1 oz. of salt of wormwood, and 4 oz. of Venice (white Castile) soap. *Or*, In 1 lb. of alcohol digest 6 days, and filter the liquid of this mixture. 4 oz. of salt of wormwood and 8 oz. of Venice soap, dissolved in a sufficient quantity of water, and evaporated.

SPRAINS.—Camphorated spirits of wine, best white-wine vinegar, spirit of turpentine, in equal quantities, mixed together, and rubbed on the part.

SPRINGS, are the outpouring of water, which, having fallen as rain, penetrates the soil till obstructed by clay and hard strata, on which it runs to lower levels; and when any cavities are full, forces its way to the surface. Sometimes they rise from great depths, and in passing through soils and strata are impregnated with salts and minerals. When deep they do not freeze, and the water is an equable temperature all the year, and in some cases higher, since the soil is 1° warmer at every 40 or 50 feet, and of uniform temperature at 30 or 40 feet deep. The finest experiments on the variable quantities of water are those made in the great mines of Cornwall, where the water is raised by powerful steam-engines to keep the workings dry. The *United mines* are in slate, and water is drawn up 98 fathoms; Dolcoath is slate, with a granite bottom 222 fathoms; and Huel Damsel in granite 202 fathoms. The surfaces are 48, 62, and 59 fathoms above the level of the sea.

The table represents the mean of the *average* monthly quantities of water pumped out of these mines, in cubic feet, and the monthly *averages of rain*, in inches for the same periods.

| Mines. | Jan. | Feb. | Mar. | April. | May. | June. |
|---|---|---|---|---|---|---|
| | cub. feet. | cub. feet. | cub. feet. | cub. feet. | cub. feet. | cub. feet. |
| United Mines ...... | 4723799 | 5436565 | 5857656 | 4895049 | 5466032 | 4394400 |
| Dolcoath .......... | 1866109 | 1723514 | 1782565 | 1722695 | 1741244 | 1615025 |
| Huel Damsel ...... | 865274 | 749640 | 880608 | 807545 | 840111 | 839807 |
| Rain .............. | 4·583 | 3·836 | 3·577 | 3·008 | 3·007 | 2·522 |
| | July. | August. | Sept. | Oct. | Nov. | Dec. |
| United Mines ..... | 4425479 | 3887360 | 3436863 | 3435319 | 3510144 | 3330284 |
| Dolcoath .......... | 1461295 | 1410007 | 1400135 | 1436790 | 1422857 | 1750345 |
| Huel Damsel ...... | 731165 | 716970 | 683521 | 669309 | 653564 | 780149 |
| Rain .............. | 2·882 | 3·985 | 3·934 | 4·928 | 4·194 | 5·543 |

The annual results of cubic feet of water drawn, and rain in inches, were :—

| Year. | United Mines. | Dolcoath. | Huel Damsel. | Rain. |
|---|---|---|---|---|
| 1826 | 49,477,875 | 18,090,219 | 8,757,924 | 33·125 |
| 1827 | 42,039,201 | 18,798,449 | 8,229,909 | 41·725 |
| 1828 | 61,269.695 | 21,676,376 | 10,890,395 | 54·97 |
| 1829 | 53,914,548 | 19,558,583 | 11,123,222 | 46 995 |

Mr. Henwood, of Truro, draws the following conclusions:—

1. That although the rain falling appears to exert, after a certain time, some influence on the quantity of water drawn out of mines, yet the amount of this effect is not in a *direct simple* proportion.

2. That although *great* differences in the quantity of rain appear to modify the quantity of water in mines, yet the variations so induced sometimes disappear when the differences of rain falling are *small*.

3. The times elapsing between the maxima and minima of rain, and those between the maxima and minima of water in the mines, are often not identical; nor are they always the same for *different mines*.

St. Winifred's-well, at Holywell, is an extraordinary natural spring, of which Popish superstition has availed itself. The rock from which it flows discharges 20 tons a minute, which, in two miles, falls into the Dee, and in the intermediate space turns from 15 to 20 water-wheels, connected with some large manufactories. The well is the drainage of three stupendous hills which lie above it.

SPONGE, is a marine production, whose great elasticity, and its property of imbibing, and as readily parting with, a large quantity of water, render it useful. It is to be chosen as light as possible, perfectly clean, and free from stone, of as pale a colour as may be, with small holes, and fine and soft to the touch. It grows in the Archipelago, at considerable depths, on the rocks, about some of the islands there: and multitudes of people make a trade of diving for it. It is also common in the Mediterranean, and many other seas, though in general browner or yellower, and not so fine as that of the Archipelago. There has been much dispute among naturalists concerning the real nature of the sponge; nor is it yet satisfactorily decided, whether it belongs to the animal or vegetable kingdom.

SPRUCE, is a tree, which forms a striking feature in the vegetation of the colder parts of North America, Asia, and Europe. The black, or double spruce, grows to the height of 70 or 80 feet, with a trunk a foot or a foot and a half in diameter. The timber is distinguished for lightness, strength, and elasticity. The red spruce is a variety, and it is chiefly with the young branches of this species that the wholesome drink called *spruce-beer* is prepared. The American silver fir rarely exceeds 40 feet. The wood is light, but slightly resinous, and bottles of the turpentine are collected, and sold under the name of *Balm of Gilead*, for certain stages of pulmonary consumption.

*Spruce Beer.*—Take of water 16 gallons, and boil the half of it; put the water thus boiled, while in full heat, to the reserved cold part, which should be previously put into a barrel or other vessel; then add 16 lbs. of treacle or molasses, with a few table-spoonsfuls of the essence of spruce, stirring the whole well together; add half a pint of yeast, and keep it in a temperate situation, with the bung-hole open, for two days, till the fermentation be abated. Then close it up, or bottle it off.

*Spruce-Beer Powders.—(For half a pint of water.)* Mix for each, in blue paper, 5 scr. of white sugar, 10 grs. of essence of spruce, and 26 grs. of subcarbonate of soda; and, in white paper, half a dr. of tartaric acid.

SQUARE, a figure of four equal sides at right angles, and the unit of all superfices; but this unit may be an inch, a foot, a yard, or a mile. Two dimentions multiplied together in either denomination give a product of squares of that kind. Thus, 8 feet by 2 give 16 square feet; or, 4 miles by 9 give 36 square miles.

There being 12 inches in the sides of a square foot, so 144 square inches are a square foot; and 3 feet in a yard gives $3 \times 3 = 9$ square feet in a yard.

To extract the square-root, or get the equal sides, which multiplied is equal to the square, as 4 of 16, 6 of 36, or 12 of 144; the ready means is to take the logarithm from any table of logarithms, adding the index, and then divide by 2. The quotient is the logarithm of the root, which may thus be determined to the smallest fraction. So, also, any root by dividing by the exponent, as by 3 for the cube-root, &c.

All areas being square numbers, the sides equal to them are found by extracting their square-root.

To square the circle nearly, for the use of mechanics, draw the diameters of the circle at right angles to each other, and produce them each way, beyond the circle, till the produced part of each diameter is equal to one-fourth of the radius; and the four points, when conjoined, form a square nearly equal to the area of the circle.

SQUILL, is a plant allied to the onion, which it somewhat resembles. The bulb has a nauseous, bitter, and acrid taste, but is destitute of any perceptible odour. It is poisonous to several animals, and, if much handled, produces ulcers on the skin. In large doses, it occasions vomiting, strangury, inflammation of the stomach and bowels, &c.; but, in small doses, acts simply as an expectorant and diuretic.

SQUIRE'S ELIXIR.—To 2 gallons of spirit of aniseed add 4 oz. of opium, 1 oz. of camphor, 1 oz. of cochineal, 2 oz. of sweet fennel, 1 pint of tincture of snake-root, 2 pints of water, and 6 oz. of bisulphuret of tin.

STAINING WOOD, is effected, for *red*, by infusing an oz. of pearl-ash and a lb. of Brazil wood in a gallon of water; letting it stand, and be stirred for two or three days, and then boiling it, and brushing it hot over the wood three or four times. To finish it, wash it with alum-water, 2 oz. to the quart. To vary the colour, vary the pearl-ash. *Or*, a lb. of logwood, with a gallon of water, and an oz. of salt of tartar, makes a deep red.

For rosewood, the chairs are dipped in the copper.

*Yellow*, is produced by a tincture of 2 oz. of turmeric to a quart of spirits of wine, standing till the desired colour is produced. Three or four washes, with intermediate drying, is necessary. *Or*, by boiling a lb. of French berries, and half an oz. of alum, in a gallon of river-water, and laying it on boiling. When dry, finish with alum-water.

*Blue*, is produced with verditer or dyer's indigo. A strong solution of pearl-ash, a lb. to a gallon, must be applied to the green stain while wet, and it changes it to blue. Hot dyer's indigo should be followed wet by a solution of ¾ of a lb. of cream of tartar in a gallon of water.

*Black* is produced by some old iron decomposed in vinegar and verdigris; or by a solution of copper in nitric acid and followed by a decoction of logwood; or by successive washings with hot decoction of logwood, an infusion of galls, and a solution of green vitriol.

*Mahogany* colour is produced by a hot decoction of 1 madder, 2 fustic, or by a tincture of dragon's blood in spirits of wine; or, by 8 madder, 1 fustic, and 2 logwood, finished with pearl-ash water.

St. ANTHONY'S FIRE, or ERYSIPELAS.—A large breakfast-cup of strong elder-flower tea, (without sugar or cream), taken an hour before breakfast, every morning for six weeks. If began when they are in flower, so much the better. If the erysipelas is out, take the cup twice a-day, but not near the time of dinner or supper.

The specific for this painful and often dangerous disease, is bark, or quinine, three or four times a day.

The common rose-infusion is useful as a prevention.

STAMMERING.—This distressing affliction may be effectually cured where there is no malformation, by perseverance, for three or four months, in reading aloud with the teeth closed, for at least two hours each day. Stammerers have no impediment when they sing or speak in a tune.

STARCH, consists of 44 carbon, 7 hydrogen, and 49 oxygen, slightly varying for different substances. When starch is the residuum of fermentation and distillation, it is soaked, pressed in sacks in a vat, ferments, alcohol is the volatile product, and starch, when dried, the residuum. Potatoe-starch is grated potatoe washed through a sieve, and the aqueous solution evaporated is fine starch. It becomes sugar, when treated with sulphuric acid. (*See* SUGAR.) When heated, it is soluble in water, and, if evaporated, yields gum; but, if dissolved in acid solutions, it becomes successively gum and sugar. The powder-blue used in washing is starch and Prussian blue. If starch is mixed in water, and set to ferment spontaneously, a fourth disappears, and gum, sugar, and amydin are formed.

Starch produces 10 per cent. more sugar than its own weight. It is to be boiled in four times its weight of water, mixed with 5 or 10 per cent. of sulphuric acid, for 12 or 8 hours, renewing the water evaporated. The sugar is formed when alcohol exhibits no precipitate. To remove the sulphuric acid, saturate with chalk, and filter. Then boil down to a syrup, and set to crystallize for two or three days. To remove colour, digest with ivory-black. The gluten of flour prevents a similar conversion. It has less carbon and more oxygen than cane-sugar, being 37 carbon, 7 hydrogen, and 56 oxygen.

Manna sugar is made by simply saturating alcohol, and the precipitate is purified manna, or crystals of sugar, with — carbon and + oxygen.

Liquorice makes its own black sugar by boiling, and gently evaporating. To purify it, mix sulphuric acid, and wash the precipitate in water, with one or two per cent. of sulphuric acid, and water only. Then dissolve in alcohol, and pour off the clear. Add carbonate of potash gradually, to neutralize the acid; filter, and evaporate. The sugar remains of a fixed yellowish tinge. Pomfret cakes are made of both, or black and white.

STAVES-ACRE, *(Delphinium,)* is an English plant; but the seeds used in medicine are Italian. It yields an alkaline poison, called *Delphine*. In infusions, it is violently cathartic, and they are often chewed for tooth-ache. The powder destroys lice in the head.

STEAM-CARRIAGES, have been treated under the head LOCOMOTIVE CARRIAGES, but in this place the following additional circumstances may be added.

Sir Charles Dance has succeeded in perfecting a steam-carriage, with which for some time he ran from the Strand to Greenwich, three times a day, at the rate of 10 miles an hour, carrying 14 or 16 persons, after running it for many months at Cheltenham.

Several, by Hancock and others, are starting on different lines of road.

Ogle and Summers are stated to have been occupied four years in experiments, and have expended 30,000*l*. in bringing their invention to that state which leaves only some minor details to be worked out. Their boiler consists of numerous sections, having sufficient connexion with each other, constructed of cylinders with air-tubes within each, standing vertically, so that a stratum of water is placed between two heating surfaces, the outer surface of the cylinders, and the inner surface of the air-tube. They allow 13 superficial feet to the horse-power, and the boiler in their vehicle contains 398 feet of heating surface, or 30 horse-power, They work at the pressure of 200 lbs. on the square inch, so that upwards of 19 millions of lbs. weight are used with perfect safety. The cylinders are 12¼ in diameter, with metallic pistons, of such perfect construction that the steam has never been known to pass these pistons. The boiler contains upwards of 56,000 rivets, and at the pressure of 300 lbs. on the inch not a rivet leaks. The joints are all perfectly tight, and the supply of water to the boiler from the tank quite perfect. The boiler is placed behind, and beyond is the blowing machine, and, owing to the heavy ironwork being at the lower part of the vehicle, an upset is almost impossible.

The boiler contains 250 superficial feet of heating surface in the space of 3 ft. 8 in. high, 3 ft. long, and 2 ft. 4 in. broad, and weighs about 8 cwt. The two cylinders communicate by their pistons with a crank-axle; to the ends of which either one or both wheels are affixed, as may be required. One wheel is found sufficient, excepting under very difficult circumstances, and when the ascent is about one foot in six. The cylinders of which the boiler is composed are so small as to bear a greater pressure than could be produced by the quantity of fire beneath the boiler, and if any one of these cylinders should be injured by violence, or any other way, it would become merely a safety-valve to the rest.

In evidence before parliament, Mr. Gurney stated, that he had kept up steadily the rate of 12 miles per hour; that the extreme rate at which he has run is between 20 and 30 miles per hour.

Mr. Hancock, with his carriage, could keep up a speed of 10 miles per hour, without injury to the machine.

Mr. Ogle stated that his experimental carriage went from London to Southampton, in some places at a velocity of from 32 to 35 miles per hour. They ascended a hill, rising 1 in 6, at 16½ miles per hour, and 4 miles of the London road, at the rate of 24½ miles per hour, loaded with people. That his engine is capable of carrying 3 tons weight, in addition to its own.

Mr. Summers stated, that they travelled in the carriage at the rate of 15 miles per hour, with 19 persons on the carriage, up a hill 1 in 12, and that he continued for 4½ hours to travel at the rate of 30 miles per hour. That he found no difficulty of travelling over the worst and most hilly roads.

Mr. James Stone stated, that 36 persons had been carried on one steam-carriage, and that the engine drew five times its own weight nearly, at the rate of from 5 to 6 miles per hour, partly up an inclination.

Mr. Farey gave it as his opinion, that steam-coaches will very soon, after their first establishment, be run for one-third of the cost of stage-coaches.

The select committee of parliament concluded their report with the following summary of the result of their inquiries abont steam-carriages:—

1. That carriages can be propelled by steam, on common roads, at an average rate of ten miles per hour.

2. That at this rate they have conveyed upwards of fourteen passengers.

3. That their weight, including engine, fuel, water, and attendants, may be under three tons.

4. That they can ascend and descend hills of considerable inclination, with facility and ease.

5. That they are perfectly safe for passengers.

6. That they are not, (or need not be if properly constructed,) nuisances to the public.

7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

8. That, as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will

cause less wear of roads than coaches drawn by horses.

Coach-masters demand a horse per mile, for going and returning, but they rest each horse every third or fourth day, and 1 in 8 are always sick or lame, so that 50 horses, for 50 miles, become 44 in work, and these, by rest, are reduced to 32. This then gives 4 horses, for 4 stages, to draw a coach from 45 to 55 cwts. 8 miles an hour for 1½ hours, so that each horse draws 12 cwt. 12 miles per day, which is equal to 7 tons 4 cwt. 1 mile. Hence, a horse on a rail-way, where the traction is 12 times less, would draw 86 tons 8 cwts, 1 mile per day, or 7 tons 4 cwt. 12 miles.

On rail-ways, a steam-engine will draw 200 tons 12 miles in an hour, which, compared with a horse at 12 cwt., 8 miles, with 12 traction, is 4000 × 12 = 48,000 to 1152, or nearly 42 to 1. Hence, the engine operates with the power of 42 horses, and if of greater estimated power, the difference is lost in imperfect contact of wheels, in friction, &c. If the horses' speed were taken at 9 or 10 miles, it would accord with cruel practices which ought not to be data, but this would reduce the engine's power only to 35 or 36 horses.

But an engine can work 24 hours per day, and a horse but 1½ hour at this rate; hence, the working power of the engine would be 16 × 42, or 672 horses.

The cost is another consideration; a rail-way of 12 miles ought to cost but 30 or 40,000*l*, but it will last 20 years. 672 horses and harness would cost 20,000*l*. renewable every four years. The coke for 200 tons, for 24 hours, would be 6½ tons, and assistants about 5*l*, but the horses would cost 75*l*. for keep.

On a *level* rail-road, the force of draught, or traction, is about the 240th, *i. e.* 1 cwt. of force is requisite to draw 12 tons. In an ascending road, this force must be increased by the ratio of the rise to the length. Thus, a rise 1 foot in 60 would demand a 60th of the weight, or 12 tons would demand 4 cwt. of force more, or 5 cwt. One foot in 100 would require 2·4 more, or 3·4 cwt. to draw it, and so on. This difficulty is obviated by a horse-wheel at the top of each plane, or by dividing the load at bottom, and re-uniting at top. A station engine, or an extra engine, requires to be made ready. But, in general, an engine does not travel with all its power, so that inclinations of 1 in 240 feet may be surmounted by enlarging the throttle valves, so as to double its own power. A heavy mass, rolling the contrary way, would obviously give the requisite force; while the pulling it up again would be convenient in descents. Lardner suggests lifting-stages, on the principle of canal locks.

On ordinary turn-pike roads, Gurney estimates the force of draught at a 12th, so that it would require 1 ton of force to draw 12 tons. On M'Adamized roads it is a 20th, that 12 tons are drawn by 12 cwt. of force.

Rail-way carriages have been forwarded by the great improvements of steam action-engines, made by Trevithic and Vivian, (who ran one in 1804;) by the fire-tubes of Booth, which give such effect to the heat in the boiler; and by sundry improvements due to the mechanical genius of Messrs. Stephenson, Wood, Braithwaite, Hancock, Gurney, and others. The world had been mystified by the atmospheric engines of Watt, till Perkins showed, that, by increasing the strength of the apparatus, we might use steam, so excited by increased motion as to press with a force of 2000 lbs. to the square inch.

The fire-tubes are now increased from 100 to 150 of 1, 1·5, and 2 inches diameter, so that no heat is lost, and the water is everywhere in contact with the pipes filled with excited air, which, in all cases, is the means of transmitting the motion of fixed oxygen to bodies within its ascending current.

For security, also, the steam is confined within plates, so that their reduced strength is a constant safety-valve.

The crank, connected with the wheels, makes a revolution at each stroke of the piston; hence, the velocity is governed by the rapid generation of steam, and this is as the heat. If the wheels are 5 feet or 16 round, 16 into the strokes per minute expresses the velocity on level ground.

It consumes 2½ lbs. of good coke in well-constructed engines, on rail-ways, to convey a ton freight 15 miles an hour, and 1½ lbs. for 11 or 12 miles. But, in drawing loaded carriages on railways, the consumption, per ton, in them, is but 4 or 5 oz. per mile, at 15 miles speed.

A loco-motive steam-carriage weighs from 8 to 11 tons; with cylinders from 10 to 14 inches diameter, and a stroke of 16 inches for wheels of 5 feet, and steam at 50 or 60 lbs. to the square inch.

A loco-motive, for rail-ways, costs from 6 to 800*l*., and, in constant work, as much per annum for repairs.

Adhesion is greatest between the same metals, less between different metals, and less between metals and stone or gravel. Nevertheless, the last adhesion has been sufficient to take a carriage, upon ascent, 1 foot in 9. This is effected by having steam at 200, and using it on a level at only 40 lbs. A steam-carriage, by itself, weighs from 2 to 3 tons.

The Author has been elaborate in his descriptions of these carriages, and in the following article, on account of their existing importance; but, within a few years, ERICSSON's *Rarified Air-Engine* will produce as great a revolution in steam-power as steam-power itself produced in water, wind, and animal power.

STEAM-ENGINE. The invention of the steam-engine is claimed by Brancas, an Italian, who used steam in coining, about 1629; and by the Marquis of Worcester, in 1663, in articles 68, 98, 99, and 100 of his Empirical Rhapsody of Wonders. Savery, Newcomen, Smeaton, Beighton, Cawley, Watt, Hornblower, and Cartwright raised it to its present importance. Several of Watt's improvements are due to others, but he judiciously adopted them in an engine for general sale and use.

Newcomen invented the steam-engine as an instrument of power; and Watt's improvement consisted in making a separate condensing vessel, so that, in cooling the steam by a shower of cold water, he did not cool the cylinder, and therefore required less fuel. Still, however, it was a reciprocating engine, useful only for raising water; but, by adopting from Washbourn the crank used in turning the old spinning-wheel, and converting the perpendicular into a circular action, the engine became applicable to general purposes, and wrought a revolution in the entire circle of industry.

If we introduce a tea-spoonful of water into a large glass globe, and exhausted of its air, and afterwards apply some heat to the globe, the water will gradually disappear, in the state of vapour or steam. By increasing the heat or motion, we augment the expansive force of the vapor; and it may be easily increased so as to shatter the globe to pieces. This expansive power, suitably directed, is the steam-engine.

Water is converted into vapor at all temperatures, even at 32°, or lower; but the elasticity at low temperatures is low; and it increases as the temperature increases, till, at 212°, it is equal to that of the atmosphere, 15 lbs. to the square inch, or capable of supporting a column of mercury 30 inches in height. In this condition it occupies 1689 times the bulk of the water from which it was formed, and has a density expressed by 0·00059, that of air being 1. Ice becomes water by communicating motion to its atoms, and water becomes steam by more motion. The atoms are the same, but reactions force them into orbits, which are inversely as the density and directly as the power of the steam.

The elasticity of steam, at 419° of heat, exerts a force equivalent to 14,700 lbs. upon every square inch of the inside of the vessel in which it is confined—a pressure so enormous that few vessels can be made strong enough to withstand it. It is obvious that the specific gravity of the vapor of water is and must be inversely as its elasticity, or as the orbits which constitute the elasticity.

Then, as steam may be immediately condensed by the application of cold, it is obvious that it may be applied as a moving force, and that it must possess unlimited power by alternate creation and destruction in a close vessel with tight valves acted on by the atmosphere.

But, in what is called the *high-pressure engine*, there is no condensation of the steam, but it is admitted alternately above and below the piston, and driven out through valves, as the piston-plate falls or rises. As this engine works simply by the dead lift of the expansive force of the steam, it requires greater strength in the machinery. The principal advantage is in power and in the economy of machinery and room. The last is properly a steam-engine and the former is an atmospheric-engine, the steam being used only to make a vacuum, and display the force of atmospheric pressure.

In Watt's atmospheric-engine the steam in a boiler is conveyed through the steam-pipe into the cylinder under the piston, where it raises the piston, and moves the great beam joined to it. A small cistern placed above the boiler is supplied with water from a hot well by a pump and pipe. To the bottom of this cistern is fitted a pipe, which is immersed in the water in the cistern, and bent to its lower extremity, to prevent the entrance of the steam. From this cistern then is suspended a heavy body, and its varied weight in and out of water opens and shuts a valve, by which water is supplied when wanted, and shut off when not wanted. Two pipes are also inserted in the boiler, at different depths, with cocks, to ascertain the depth of water at any time. A safety-valve in the boiler regulates the pressure to the strength of the boiler, and by drawing up the valve by a chain over a pully the engine may be immediately stopped.

From the dome of the boiler proceeds the main steam-pipe into the top of the cylinder by a valve, and into the bottom by another valve, called steam *induction*-valve. The cylinder is sometimes enclosed with a wooden case and ashes, to prevent the radiation of heat. —The steam admitted by the valves raises and depresses the piston, and then escapes by other valves close to the others, (called steam *eduction*-valves,) into the condenser *beneath*, where it is converted into water by a jet of cold water, and this condensed steam is carried to a hot well by an air-pump, worked by a rod from the main beam. From the hot well it is pumped to the cistern over the boiler. The water surrounding the air-pump supplies the jet, and is supplied by a pump worked by a rod on the other side the fulcrum of the great beam. The several valves are opened and shut by rods from the piston-rod of the air-pump.—The main piston-rod passes through a collar of leathers or caoutchouc, at the top of the cylinder. The top is fixed to machinery, called the parallel joint, which enables the piston-rod to move up and down perpendicularly as a tangent instead of chord to the circle which the beam-end performs. This machinery or joint performs the motion between the chord and tangent, and hence the piston-rod itself works upright.

Then, as the steam raises the piston-valve, it raises a rod attached to the beam, and the atmospheric pressure sends it down again, with the rod and beam-end. But, in many engines, there is a second cylinder with a rod attached to the other end of the beam, conferring double force on its action; and sometimes two cylinders at one end, for the beam is made equal to any degree of purchase.

Then, to convert the reciprocating or oscillating motion of the beam into a rotatory motion, a rod from the end of the beam is connected with a crank on an axle, on which is fixed a wheel with cogs, and these being connected with other wheels, shafts, straps, &c. constitute the machinery of our various manufactories.

Connected by a strap or rope with the fly-wheel is the revolving governor, which by a rod operates on the induction steam-valve pipe of the cylinder.

High-pressure engines act by the force of steam alternately at the top and bottom of the piston, and include no condensing apparatus, and no vacuum for the pressure of atmospheric air. Hence, instead of 10 or 12 lbs. to the square inch (depending on the 15 lbs. of atmospheric pressure on the vacuum beneath the piston) the force of the steam lifts and depresses the piston, and the steam escapes on its ascent and descent. In this way the piston acts with a force of 50, 100, 200, &c. lbs. to the square inch, and in Perkins's of 2000 lbs. and upwards, and its power is limited only by the strength of the materials, the valves, &c.

The patent engine of Perkins, and of Trevithic and Vivian, is the most approved for these engines. The fire is placed within the boiler, and in every way rendered efficient, and the piston is in immediate connection; and, as it can work either vertically or horizontally it is admirably adapted to steam-carriages, since the piston-rod itself at once turns round the cranks on the axle of the wheels.

The four-way cock, invented by Papin, transfers the steam to the top and bottom of the piston from the boiler, and again to the condensor, by simply turning a plate a quarter of a circle.

Watt invented and applied a small instrument, which he called an *Indicator*, to his steam-engine. It indicates what extent of plenum and vacuum is alternately formed within the cylinder, in order to impel the piston when the engine is at work.

Of course, the power in the steam and steam-engine is entirely derived from the fire, the power of the fire from the atmosphere, the power of the atmosphere from the oxygen in it, and that of the oxygen from the motion of its atoms. Put out or damp the fire and the engine stops. Shut out the atmosphere, by covering the fire partially or wholly, and you stop the engine. Again, absorb the oxygen and the engine stops for want of fire. Absorb the oxygen by carbon (carbonic acid) and the cause is arrested, and the effect ceases. In a word, the oxygen gives power to the air, to the fire, to the water, to the steam; and then the apparatus, the enclosed boiler, the induction-pipes, the cylinder, the piston-rod, the beam, &c. are mere means of reacting, conducting, and directing this power to a desirable effect.

A *second* power has, however, been interposed, that of atmospheric pressure. The *first* power was not understood, or was lost sight of, but was considered merely as a suitable contrivance by which to bring the *second* power into action. It overcame the elastic power of the atmosphere, and yet was easily condensable, and therefore it presented a ready means of generating *a large vacuum*, and then the ordinary pressure of the atmosphere on the piston-plate does the rest—it pushes down the raised piston, and thereby is made the second mover of the machinery.

There is palpably much complication in all this. Yet this is the engine of Newcomen of Dartmouth, adapted for commercial sale by Watt. It is efficient, but a complication of two distinct powers, that of steam and that of atmospheric pressure. The complication is removed by high-pressure engines, in which the steam let in at the bottom raises the piston, and then let in at the top depresses it. We thus get one step nearer the mobile atoms of oxygen, and the origin of the force, and we save much space and machinery, but require greater strength, and more caution. But we still have, between the effect and the first power, the water, the fire, the oxygen, &c. The great waste of power, in converting water into steam, condensing, &c. is, however, obviated by the new Aerial engine of Ericsson.

Vapour is the atoms of a fluid diverged

or propelled into air when their motion or excitement exceeds the force of the elastic pressure of the gas in the space, as of air of 15 lbs. to the square inch. Its production is a palpable result of motion, and nothing but motion. A cubic inch of water becomes very nearly a cubic foot as vapour, or steam of the first degree, exactly 1689, and there are 1728 cubic inches in a foot. When water is at 212, it requires 6 times the heat to vapourize a foot that it did to raise a foot from ice to 212°; and if 1 foot of water, as steam, be mixed with 6 of water at 32, it becomes 7 at 212, shewing that there is 6 times the motion in steam that there is in water, yet, as density is inversely as bulk, a thermometer in such steam-still stands at 212°.

The *power* of every stroke of an engine is easily estimated. Square the inside diameter of the piston in inches, and multiply by 0·7854. *Or*, square the inside circumference in inches, and multiply by 0·07958. Then, with an atmospheric power, multiply by 15, and allow for friction and loss of power a fourth or fifth. With a real steam-power or high-pressure engine multiply by the number indicated by heat less the atmospheric pressure, as 50, 200, or 300, as it may be, and allow a fifth friction.

Effect, or work, is as the number and length of strokes per minute, since the power is the multiple of the first force by the velocity.

Eight square feet of the surface of the boiler must be acted on by the fire, to convert a cubic foot of water into steam in an hour, and then it becomes 1728 cubic feet; that is, from 1 foot each way to 12 feet in each dimension. The number of atoms is the same, and they merely fill a larger space by their combined motions.

The power is equal to the expansion or volume. At 212, the steam to the water is as 1728 to 1, which give a force of 15 lbs. to the square inch; but, at $227\frac{1}{2}°$ to the volume is 5 times greater, or 9000 to 1; at $250\frac{1}{2}$, is 15 times greater, 27,000 to 1; and, at 282°, is 40 times greater, or 72,000 steam to 1 of water, with a power of 55 lbs. to the square inch. Brunton says it may be expanded to 400 times its bulk at 212°. Its force depends on the power and continuity of compression, or reaction, and the vast increase is an accelerated power.

Steam itself, passed in pipes through water, is a ready means of raising it to the boiling point. 17 gallons of water, in steam, will raise 100 gallons at 60° to the boiling point. The quantities, at any heat, may be determined 212 less the heat of the water, into the quantity to be heated, being equal to 900 into the quantity to be raised as steam for the purpose.

Eighty-four lbs. of Newcastle coals, 112 lbs. of Scotch coal, 252 lbs. of wood, and 200 lbs. of culm, produce equal quantities of steam.

One-horse power per hour requires 17 lbs. of coals, 34 of culm, and 50 lbs. of wood. A very important and universally-approved regulator of supply of fuel, seen in many engines by the Editor, is BRUNTON's Apparatus. It produces that desirable result, uniformity of action, and saves full 30 per cent. in fuel. Its ingenuity and utility cannot be too highly extolled.

In boilers, Watt allowed 25 cubic feet for each horse-power, or 2 feet 11 in. in each dimension. Their capacity is adapted to two horses more than the estimated power.

The safety-valve, the loss of heat, the imperfection of the vacuum, and the diffused action of the steam, reduces its effective force from 15 lbs. to 10 lbs. The power therefore, is 10 lbs. for every square inch, in the area of the piston, multiplied by the travelling rate of the piston. Then, if this be divided by 44,000, we get the number of horse-power of the engine very nearly.

If we take a cylinder, three feet in diameter with stroke of four feet, the equation is as under, and it may be varied in any of its terms, keeping the equality. $36^2 \times 0{\cdot}7854 \times 10$ lbs. $\times$ 200 ft. = 44,000 $\times$ 46·2672 horses' power.

Hence, if we want a 80-horse-power, we must increase 36 and 200 accordingly, since 0·7854 and 10 lbs. and 44,000 are constant, and 80 is given.

Brunton says, the contents of the air-pump, in Watt's engine, ought to be equal to a fourth of the contents of the cylinder, and that the condenser ought to be more. Each horse-power requires $7\frac{1}{2}$ gallons of water per minute.

In steam-power, a cylinder of 26 in. will grind $2\frac{1}{2}$ quarters per hour, and 1 of 32 inches, 4 quarters. Every 5, 4, or 3 inches performs an extra quarter.

In London steam-engines of magnitude they consume 8 lbs. of coals in the production of a cubic foot of steam. At the West Middlesex Water-works there are three engines, one of 100-horse power and two of 70-horse. They supply 16,000 houses, each, on the average, with 168 gallons per day. The consumption of coals is 9 cwt. per hour, for the two engines. The pistons are $4\frac{1}{2}$ feet diameter, and the forcing vessels 5 feet 8 inches, the water being distributed in a radius of five miles, and raised 180 feet high. The 100-horse engine cost £4500 when delivered, and the building, with other expences, were £15,000. The average work of the engines per day is nine hours, and their action about 11 lbs. to the square inch, the area of the 70-horse piston being, therefore, 2300 square inches, at 11 lbs. each, the force is 25,300 lbs. per stroke of the 70-horse, and 30,000 of the 100-horse, or 12 and 14 tons per stroke. The supply is 2,700,000 gallons nearly, weighing 10 lbs. each, or 27 millions lbs. Nine cwt. of coals is 1008 lbs., generating 126 cubic feet of gas.

Sundry plans, improved valves, and contrivances, have been adopted, to prevent the explosion of steam-boilers. Ingenious ones have been published by Ewbank, Cadwallader, Evans, and Ingham, an American. The latter proposes double vessels, and water, under atmospheric pressure, to lie in the space between both.

There are, in Great Britain, many very ingenious steam-engine makers, each of whom compete, in perfection and price, and most of whom have some improvement, secured by patent.

Perkins's Steam Generator consists of a copper globe or cylinder, three inches thick, holding eight gallons, and competent to sustain an explosive action of 4000 lbs. to the inch. He heats this ball to a white heat, and forces the water into contact with the metal, so as to get steam with a pressure of 500 lbs. to the square inch. The valve bears 560 lbs., and the steam which flashes from it, as other water is injected, acts with a force exceeding 450 lbs. By flashes of this steam, passed through a gun-barrel, he projects balls with the force of gun-powder, and as rapidly as 100 in a minute, forming one of the most destructive missiles of war ever invented, and such as, if used, would soon put an end to all war. He asserts that more persons have been killed by *low* than by *high* pressure boilers in this country, and that such has decidedly been the case in America.

It appears, by his experiments, that water does not approach the surface of red-hot iron at a white heat, and that it does not come into contact with the iron till after six evaporations, whose time varies from 90 to 12 seconds; but the 7th, which evaporates in 6 seconds, is in contact, and made in 6 seconds, and this he calls the evaporating point.

Perkins's High-Pressure and Safety-Engine is made applicable to all purposes of steam navigation, and consists of a steam-pipe from the generators, conveying the steam to the admission-valve, lying horizontally at the back of the cylinder, from whence it acts on the underside of the piston at a pressure of 2000 lbs. on the inch. The cylinder is about a 15-horse-power; the piston only six inches in diameter; and the length of stroke only 20 inches.

Palmer's apparatus, as well as Brunton's, consumes the smoke, or supplies sufficient air for the purpose, either by condensation or exhaustion, turning from right to left or left to right.

By placing vane-wheels within the chimney of the boiler of a small steam-engine, the smoke and hot air is returned through the fire and passed downwards, in a current, towards the ground. Sometimes an air-pump has been used instead of a fan, and no chimney is requisite; hence steam-carriages emit no smoke.

The improvements of Cartwright were most important, but he was merely a man of science, and not a trader in such articles.

The French Academy lately appointed a committee to ascertain by experiment "the elastic force of the vapour of water at high temperatures." The labour devolved on Messrs. Dulong and Arago; and, that no error dependant on valves should interfere, it was resolved to estimate the force exerted by the height of the column of mercury sustained. A glass tube was accordingly prepared, consisting of 13 pieces, 78·74 inches each in length, and 0·2 of an inch in diameter. Each piece was supported by stays, so that the lower should not be crushed by the upper; and the whole was erected in a square tower. The following table shows the results obtained experimentally up to 25 atmospheres, extended to 50 by calculation. The committee express their conviction, that, at 50 atmospheres, or 750 lbs. to the square inch, there cannot be an error of more than 0·1 of a degree:—

| *Atmosph.* | *Fahr.* | *Atmosph.* | *Fahr.* |
|---|---|---|---|
| 1 | 212 | 10 | 358 |
| 2 | 250 | 15 | 392 |
| 3 | 275 | 20 | 418 |
| 4 | 293 | 25 | 439 |
| 5 | 308 | 30 | 457 |
| 6 | 320 | 35 | 472 |
| 7 | 331 | 40 | 486 |
| 8 | 341 | 45 | 491 |
| 9 | 350 | 50 | 510 |

Maudsley's steam-engine has no reciprocating beam, but works by a direct stroke of the piston, and is a very simple and perfect engine.

Hall's steam-engine condenses the steam by means of 77 tubes in cold water, constituting a refrigerating apparatus, and the same pure water is then returned to the boiler. This steam-engine reduces the consumption of coals, in 12 hours, from 22 cwt. to 9, and performs 30 per cent. more work.

*Steam Boilers.*—By royal ordinance, in France, it is decreed, that every boiler employed in public works or manufactories, where steam is equal to two atmospheres and over, shall have—

1. Two safety-valves of equal dimensions, and each of sufficient size to discharge the steam freely, in case of its too great tension.

2. Each valve shall be loaded by *direct* pressure, and without the intervention of a lever, with a weight equivalent, at most, to one atmosphere.

3. Near one of the valves on the top of the boiler there shall be adapted a metallic plug, fusible at the temperature of 260·6° Fahr. This plug shall be of such a diameter that its free surface shall be four times as great as that of one of the safety-valves.

4. One of the valves and the fusible plug shall be locked up under the same grated enclosure, and the key shall remain in the hands of the principal of the establishment. The other valve shall be under the direction of the engineer of the machine.

5. Each boiler shall be furnished with a manometer, open to the air, the glass tube of which shall terminate at the height of 30 inches above the level of the mercurial surface pressed by the vapour.

*Heating by Steam.*—It has been ascertained that one cubic foot of boiler will heat about 2000 cubic feet, 12½ feet each way, to an average heat of about 70° or 80° Fahr. And one square foot of surface of steam-pipe is adequate to the warming of 200 cubic feet, 6 each way. This quantity is adapted to a well-finished ordinary brick or stone building. Cast-iron pipes are preferable to all others for the diffusion of heat, the pipes being distributed within a few inches of the floor.

Steam is used extensively for drying muslin and calicoes. Large cylinders are filled with it, which, diffusing in the apartment a temperature of 100° or 130°, rapidly dry the suspended cloth. Experience has shown that bright dyed yarns, like scarlet, dried in a common stove-heat of 128°, have their colour darkened, and acquire a harsh feel; while similar hanks, laid on a steam-pipe heated up to 165°, retain the shade and lustre they possessed in the moist state. Besides, the people who work in steam-drying rooms are healthy, while those who were formerly employed in the stove-heated apartments became, in a short time, sickly and emaciated. The heating, by steam, of large quantities of water, or other liquids, either for baths or manufactures, may be effected in two ways: The steam-pipe may be plunged, with an open end, into the water-cistern; or the steam may be diffused around the liquid in the interval between the wooden vessel and the interior metallic case. The second mode is of universal applicability.

Cooking food, both for man and cattle, is another useful application of steam; for it is the most effectual carrier of heat that can be conceived, depositing it only on such bodies as are colder than boiling water. Chambers filled with steam, heated to about 125° Fahr., have been introduced, with advantage, into medical practice, under the name of *Vapour-baths.*

*Steam Thrashing-Machine.*—Hitherto low-pressure engines only have been applied to the thrashing-machine; but Mr. Burstall has been lately engaged in introducing extensively the high-pressure: 1st. Such engines are considerably cheaper in the original cost; 2d, They do not require more than 1-12th or 20th of the water which a condensing-engine requires; and, 3d, A knowledge of their management is more easily acquired. They are thus rendered more fit for farm labour, and, when properly made, are as safe as atmospheric engines.

*Steam-engine Ploughs* have been invented, and that by Phillips will plough an acre in two hours and a half with six bushels and a half of coals, and one man; being the work of two or three horses, and two men per day of eight hours. But, as a steam-engine would work 10 or 12 hours, so the work would be four or five acres in the day, with half to three-fourths of a ton of coals.

STEAM-VESSELS.—For 30 or 40 years after steam-engines had been generally introduced into mines and manufactories, an error prevailed that a rotative motion of paddles would not carry forward a vessel in water, nor the turning of a wheel project forward a carriage on a railway or road. When Fulton, in 1807, acquainted the Author of this Volume with the success of his voyage up the Hudson, in a letter, written on the evening of the day it took place, the Author proceeded, with Fulton's account, to Earl Stanhope, Mr. Farey, Mr. Brathwaite, and others; but they treated his faith in Fulton's rapturous narrative with ridicule; and Earl Stanhope drew some diagrams to *demonstrate* the impossibility of Fulton's assertion. And, so firm a faith also prevailed, that the friction of wheels would not propel a carriage, that Blenkinsop took out a patent for railways with cogs, and Brunton for an apparatus to push a carriage by levers from behind.

It appears that John Smith, of St. Helen's, under the patronage of Mr. Baldwin, the aeronaut, of Prescott, was, in 1793, the first constructor of a vessel navigated by steam.

It is pretended that a Mr. Symington first made a steam-boat, in Scotland, but his claim is defeated by the clear and conclusive evidence which Fulton exhibited, in a court of law, of his having submitted a plan, analogous to that he afterwards carried into effect, to

Lord Stanhope, in 1795, six years prior to the experiment of Symington. Fulton, after having occupied himself at Paris, in the investigation of the capabilities of different apparatus for propulsion, was finally led to the conviction, that, of all methods proposed, paddle-wheels possessed the greatest advantages. He next planned a mode of attaching wheels to the engine of Watt. A vessel was then constructed at Paris, and, being launched upon the Seine, performed its task in exact conformity to his anticipations. This experiment was performed in 1803. The trial having proved successful, it was resolved to take immediate measures to have a boat of large size constructed in the United States. The engine reached New York towards the close of the year 1806, and the vessel built to receive it was set in motion in the summer of 1807.

Steam-boats were introduced into Great Britain in 1812. Bell built the first boat upon the Clyde, and, in March 1816, the first steam-boat crossed the British Channel from Brighton to Havre.

A steam-apparatus, for propelling a vessel, consists merely of an engine of sufficient power to rotate an axle, on the ends of which are affixed wheels, somewhat similar to the water-wheels of an undershot-mill, and which work by the sides of the vessel. The power varies from 30 to 300 horses, according to the size of the vessel, the proposed velocity, or the current to be resisted. The paddle-wheels are variously constructed, and, for improvements, there are many patents. Among others, Mr. Perkins, to whom the mechanic arts are under many obligations, has invented a paddle, whose effect is beautifully exemplified at the Mechanical Gallery.

High-pressure engines, with safety-valves, are generally used in steam-vessels, owing to their being, with equal power, but two-thirds or half the weight of low-pressure ones, and having power to meet emergencies; but, with due regard to passengers, the metal should be copper, which rends, and a stout iron-grating ought to separate the engine-room from the cabin. Passengers, especially females, cannot divest themselves of fear, and this feeling is not sufficiently respected.

As steam-navigation took its rise on the Hudson, so the steam-boats navigating that river have uniformly been before all others in point of speed. Two vessels on this river have a speed of 13½ miles per hour. The wheels of the New Philadelphia average 25½ revolutions in a minute; and the piston moves with a velocity of 405 feet per second.

The North American steam-vessel, of 700 tons, with 4 feet 6 inches draught, has made the voyage, 160 miles up the Hudson, in 10 hours 10 minutes, and down in 10 hours 20 minutes.

The amount of steam-boat business in the United States has been increasing immensely since 1824. One boat on the Hudson, built in 1825, has carried nearly 200,000 passengers; and there are now 20 on that river. Only 10 days are required for a steamer to ascend from New Orleans to Cincinnati. The whole number of steam-boats which had been built in 1830, upon the western waters, was about 375. Some of them are 500 tons and 300 feet long. Thus the Mississippi and its innumerable branches, separated from the Atlantic coast by ridges of barren mountains, and almost inaccessible from the Gulf of Mexico by either sails or oars, has become the seat of flourishing settlements, and vies in commerce with maritime regions.

Iron steam-boats have lately been constructed, which, without apparatus, draws 11 inches, and with apparatus 22 inches, fore and aft.

The British steam-vessels keep pace, in science and practice, with those of the United States, and, however much their great waters and rivers may be covered with them, our channels, ports, and rivers, display them in motion. Where-ever a current does not exceed 8 miles an hour, they make way; but they have, from this cause, failed on the Danube.

Having rendered the internal parts of America maritime, they are likely to effect the same benefits for Africa.

They are the greatest social improvement ever made; and, followed as they will be, by locomotive-carriages on roads, as well as railways, they will change the face of every civilized country. As a lesson, the Editor will add to the fact mentioned in the first paragraph of this article, that from respect to his friend Fulton, he duly announced his success, and publicly advertized for a subscription in £10 shares, to repeat the experiment on the Thames, but, after three months, he obtained but two names for single shares! So it has been with all the great improvements of the last half century—we have genius without capital, but abundance of capital without a spark of genius in its possessors.

*Paddle-wheels.*—The shafts, or axles, are placed as nearly as may be in an horizontal plane, and are so inclined towards each other, and towards a perpendicular plane, passing through the keel of the vessel, that if produced backwards, they would meet in such perpendicular plane, and form with it an angle of 45 degrees, and, with each other, an angle of 90 degrees, pointing towards the stern of the vessel. The shafts, or axles, being so inclined, pass obliquely forwards through the sides of the vessel, and the wheels being fixed with their planes at right angles to the shafts, look obliquely forwards, and outwards, and, as a consequence of that position of the axles before-mentioned, inclined from the sides of the vessel at the places near which they are applied. The floats, or paddles of the wheels, must be so set, or fixed, as that each of them shall stand at an angle of about 45 degrees to the plane of the wheel's motion, to the end and intent that each float, or paddle, when in the lowest part of its rotation, may make a right angle with the keel of the vessel, or act directly in the line of the vessel's way; and the uppermost paddle be parallel to that way, or to the keel. To effect these ends, all the paddles of the upper halves of both the wheels must have their inner edges pointing backwards, or towards the stern of the vessel, and their outer, or extreme edges, in the direction of the vessel's way, or towards its head. The floats, or paddles, are fixed in the nave, or boss of the wheel, and radiate from its centre.

The practical effect of the above construction is, that the paddles enter and leave the water *in an oblique direction*, and that the lowest paddle always moves in the most advantageous manner for propelling, or backing the vessel, and the uppermost one in the precise direction of the vessel's way, or parallel to the keel, and meets with little impediment in its passage through the air, whilst the oblique position of the wheels, with reference to the side of the vessel, gives room for the water to escape.

In the arrangement above described, the wheels will be much more deeply immersed in the water than in the ordinary arrangement of paddle-wheels, which more than compensates for the loss of power occasioned by narrowing the paddles.

A patent has just been taken out for acting against the water by a revolving screw, of sufficient dimension and angular power.

STEAM-GUN.—In 1814, a French engineer constructed ordnance of this sort. The generator supplied, at once, six pieces of artillery with steam. The turning of a cock supplied all the pieces at once with balls and steam, and this machine could make 150 discharges in a minute. The steam-gun, invented by Perkins, is thus described by him:—"I am now engaged in building steam-artillery, as well as musketry, for the French government. The piece of ordnance is to throw sixty balls, of four pounds each, in a minute, with the correctness of the rifled musket, and to a proportionate distance. A musket is also attached to the same generator, for throwing a stream of lead from the bastion of a fort, and is made so far portable as to be capable of being moved from one bastion to another. The musket is to throw from one hundred to one thousand bullets per minute, as occasion may require, and that for any given length of time. I am within the truth, when I say that, if the discharges are rapid, one pound of coals will throw as many balls as four pounds of powder."

If this mode of attack and defence can be realized, and there seems to be no reason against it, civilized Europe may calculate on protection against the Northern Colossus, and its barbarous myriads. In union of civilized policy, there appears to be no dependance.

STEEL, is a compound of iron and carbon. Pliny says, that, in his time, the best steel came from China, and the next best from Parthia. The process for converting iron into steel, called *cementation*, originated in Sheffield.

The furnace in which iron is converted into steel is like a large oven, or arch, terminating in a vent at the top. Immediately under it there is a large arched fire-place, with grates, which runs quite across from one side to the other, so as to have two doors for putting in the fuel from the outside of the building. A number of vents, or flues, pass from the fire-place to different parts of the floor of the oven, and throw up their flame into it, so as to heat all parts of it equally. In the oven itself there are two large and long cases or boxes, built of good fire-stone; and, in these boxes, the bars of iron are disposed in strata with charcoal-powder, ten or twelve tons of iron being put in at once, and the box is covered on the top with a bed of sand. The heat is kept up, so that the boxes and all their contents are red-hot for eight or ten days. This process is called *cementation*, and the steel produced is called *blistered steel.*

The steel is then heated red, and drawn out into smaller bars by a *tilting hammer*, and called *tilted steel.*

By fusing in a crucible, and casting in bars, it is called *cast steel.* The crucible is exposed for five or six hours to the most intense heat that can be raised, by which the steel is brought into a state of perfect fusion; and, to fuse one ton of steel, about 20 of coals are expended.

The sp. gr. of blistered steel is 7·823, and when heated to redness, and suddenly plunged into cold water to harden it, its sp. gr. is reduced to 7·747.

The color of steel is whiter than iron. Its texture is granular, and not hackly, like that of iron, and the fracture is whitish-grey, and smoother than iron.

To combine the extreme hardness of

steel with the toughness and tenacity of iron, they are welded together, and thus edge-tools are made. Steel is welded to the iron on that side of the plate which is to be worked into an edge; or the surface of a piece of iron is converted into steel by cementation, and the process is stopped before the carbon penetrates so far as to convert the whole piece into steel. The process is called *case-hardening*.

To harden steel work, Stodart enclosed it in a tube surrounded with an alloy, 8 lead, 2 tin, 5 bismuth, and heated them to redness. He then plunged them into a cooling liquor; boiling water then fuses the alloy, and the steel is found hardened and quite perfect. Water at 40° is the best cooler, and snow is not better.

Sheer steel is used for table-knives, &c. The tang and shoulders are iron, welded to the steel blade.

To preserve steel from rust, Stodart's method is to wash with the ethereal solution of gold, or with muriate of platina. In this way, the breadths of polished steel in grates, fenders, &c. are preserved; and either may be purchased of chemists, or furnishing ironmongers.

Steel heated a little above the degree necessary to temper it, becomes soft, by that very operation of tempering, and this process, for nealing it, is much superior to the ordinary methods. The process in no way deteriorates the steel and abridges the operation.

*Steel-hardening* is a very important process, in connection with steel-engraving, and die-sinking. The subject is engraved on cast-soft steel, and then is hardened by placing it in a cast-iron pot, surrounded with animal charcoal. It is then exposed to intense heat of coke in an air-furnace, and afterwards placed in a vessel of cold water, renewed by a current. It is then used to make a punchion-die on other soft steel to be hardened, and this is a matrix for others, by which coin may be struck.

Every kind of iron is not suited to become steel. The iron which answers best is made at Danemora, in Sweden, and the whole produce of the Danemora mines, amounting to 8000 tons, is imported into Britain by a single house, and the cementation is performed at Sheffield, by Sanderson and Co. who export steel to all parts of the world.

In the United States there are fourteen steel furnaces, capable of affording more than 1600 tons of steel annually. The French and Germans also make much steel. The finest steel articles are made at Woodstock, and the manipulations often raise the value 5000 per cent.

A suspension-bridge of German steel has been lately erected over the Danube, near Vienna. The span is 234 feet, and the versed sine 15 feet. A saving of one half in the total weight is calculated to have been effected by the employment of steel instead of iron, and the strength is much greater.

*Steel for Damascus sword-blades.*—An imitation of the celebrated "Damascus blade," stated to be in no respect inferior to the Eastern original, has been fabricated in Austria and Prussia; and Crivelli, the inventor, has published the following details:—A long flat piece of malleable steel, of about one inch and a half in breadth, and one-eighth in thickness, is to be first bound with iron-wire, at intervals of one-third of an inch. The iron and steel to be then incorporated by melting, and repeated additions (10 to 20) of iron-wire made to the first portion, with which they must be firmly amalgamated. This compound material is then to be stretched, and divided into shorter lengths, to which, by the usual process of melting, grinding, and tempering, any wished-for form may be given. By filing semicircular grooves into both sides of the blade, and again subjecting it to the hammer, a beautiful roset-shaped Damascus is obtained; the material can also be made to assume any other form. The infusion by means of which the figures are made visible, is the usual one of *aqua-fortis* and vinegar. An idea of their extraordinary tenacity may be formed from the fact, that out of 210 blades that were examined by a military commission, and each of which was required to bear three cuts against iron, and two against a flat wooden table, not a single one snapped, or had its edge indented.

*Steel wine.*—In a pint of sherry, or madeira, digest for three days 1 oz. of iron filings, and 2 drs. of crocus (*red*, or *per*-oxide of iron). Strain for use.—*Or*, in a pint of Rhenish wine digest, one month, 1 oz. of iron filings, with 1 dr. of cinnamon and of mace.

STEERS' OPODELDOC.—In 3 galls. of alcohol mix 3 lbs. of Castile soap, 2 lbs. of caustic ammonia, 14 oz. of camphor, 3 oz. of oil of rosemary, and 6 oz. of oil of thyme. *Or*, In two pints of alcohol mix 1 lb. of white soap, 2 oz. of camphor, and 4 oz. of oil of rosemary, and 1 oz. oil of thyme.

STEMS of vegetables, increase in diameter in two ways. 1. By the addition of new matter to the outside of the wood, and the inside of the bark; called *Exogenous*. 2. By the addition of new matter to their inside, called *Endogenous*.

In *Exogenous*, the central portion is called *heart-wood*; while the exterior is called *alburnum* or *sap-wood*. The inside of the bark of such stems has the technical name of *liber*.

The secretions by which heart-wood is solidified are prepared in the leaves, whence they are sent downwards through the bark, and from the bark communicated to the central part of the stem, and the channels through which this communication takes place are called *medullary rays*, or *silver grain*. The wood itself is composed of tubes, consisting of woody fibre and vascular tissue, imbedded longitudinally in cellular substance, which only developes itself horizontally.

The weft is cellular tissue, and the warp is fibrous and vascular tissue.

In *Endogenous* stems the portion at the circumference is harder than that in the centre; and there is no separable bark, as the cane. Their stems consist of bundles of woody matter, imbedded in cellular tissue, and composed of vascular tissue surrounded by woody fibre.

STENCILLING, is drawing upon walls in water-colours, and often so beautiful as to merit general encouragement.

STETHOSCOPE, an instrument consisting of a short tube, widening towards one end, with which physicians examine the internal state of the human body, in diseases of the lungs and other internal organs; also in hernia, and the condition of women in pregnancy, &c. by applying the stethoscope to the chest or abdomen, and putting the ear to the narrower end. Many disorders may be distinguished very clearly in this way.

STICKING-PLASTER, OR COURT-PLASTER.—The basis of the first stratum is isinglass. Bruise a sufficient quantity of isinglass, and let it soak for twenty-four hours in a little warm water; expose it to heat over the fire, to dissipate the greater part of the water, and supply its place by proof spirit of wine, which will combine with the isinglass. Strain the whole through a piece of open linen, and take care that the quantity of the solvent be such that on cooling it shall form a trembling jelly.

Extend a piece of black silk on a wooden frame, and fix it in that position by means of tacks, or pack-thread. Then, with a brush made of badger's hair, apply the isinglass, after it has been exposed to a gentle heat to render it liquid. When this stratum is dry, which will soon be the case, apply a second, and then a third, if you are desirous of giving the plaster a certain degree of thickness. As soon as the whole is dry, cover it with two or three coats of a strong tincture of balsam af Peru.

A kind of plaster, the covering of which is very thick and brittle, is often sold under the same name. The fabricators, instead of isinglass, which is dear, employ common glue, which they cover with spirituous varnish.

Moisten it with saliva, or warm water, on the side opposite to that which is varnished, and it will adhere well.

The simplest plaster is gold-beaters' skin, the object being to keep the oxygen of the atmosphere (the feeder of inflammation) from the wound; and the materials of common sticking-plaster contains much oxygen. The best dressing is a layer of gold-beaters' skin, and a piece of sticking-plaster laid on this. In 99 cases in 100 the wound heals before the dressing wears off.

STILLS, are very simple vessels, consisting of a body, a head, and a neck, running into a spiral tube in another vessel filled with cold water. The vapour or spirit is thereby condensed, and runs into a receiver. As some aqueous vapour rises, the product is often subjected to a second, and even a third distillation. The higher the vapour ascends the purer is the product. Distilling has been treated at large, under the word DISTILLATION, &c. The forms and improvements are various, but the principle is the same.

Sometimes distilling is applied to cases in which gases are evolved by great heats from solids, as in the case of carburetted hydrogen from coals, which, put into retorts, and placed in a furnace, are said to be distilled.

SAINTMARC'S STILL produces from the wash, at one operation, a fine and strong spirit; results of, at least, three distinct processes, in two separate stills; and this is effected by an apparatus less costly in erection than those now in use; requiring less space, a diminished number of vats, pumps, pipes, &c.; and a small expenditure of fuel and water.

These advantages result from the employment of furnaces of small dimensions, and a perfect economy of every portion of the heat generated, which gradually prepares each succeeding quantity of the wash for prompt and perfect distillation, when brought into contact with the fire.

The still consists of eight copper vessels, or compartments, surmounting each other, of which the seven lowest are charged with wash to a certain height. The lowest of these is alone submitted to the action of the fire. The vapour, proceeding from the wash contained in it, passes through double tubes into the wash within the second copper, which it speedily raises to the boiling point; thence it proceeds through similar tubes into the wash of the third copper, which is also made to boil. The vapour subsequently passes into close domes in the several coppers above, each of which is entirely surrounded with wash, except the highest, which contains water. In this passage upwards, all the weaker portions of the vapour are condensed; and none but that which is of an alcoholic nature, (of the strength of 35 to 40 per cent. over proof,) passes through the worm into the spirit-receiver. Thus, there is one distillation by fire, and two by vapour, all going forward at the same time, besides five purifying and strengthening processes, in regular and immediate succession, by which all empyreumatic or other flavors are destroyed.

By this succession of operations, the wash is continually prepared for distillation, by a graduated heat, as it descends in the still. When the spirit is quite distilled from the wash, in the lowest compartment, it is drawn off, and the cock communicating with the second is turned, which instantly brings down the contents of that vessel into the lowest. To replace what is drawn out of the second vessel, a lever is raised, connected with a plug in an exterior vessel, surrounding the highest compartment of the still, (which exterior vessel contains a quantity of wash, equal to a charge of one copper,) and discharges its contents into the compartment next below, displacing an equal quantity from vessel to vessel, down pipes, extending from the level of the wash, in one compartment, to the lower part of the next, from the seventh copper down to the second, which is thus immediately replenished, without, for a single instant, suspending the process; and a new charge being drawn from the vat into the exterior vessel at the summit, the distillation may be carried on *ad infinitum*.

STOCKINGS, an elastic weaving of worsted, cotton, thread, or silk, formerly effected by the hand with long needles; but, about 1589, the stocking-weaving frame was invented by Lee, of St. John's, Cambridge, and is now in general use, though the decided superiority of knit-stockings still causes a demand for them. This frame so multiplies the article, that stockings, which could not be knit in a week, are now sold at 7*s*. or 8*s*. the dozen pair, and retailed at 9*d*. or 1*s*. per pair. The stocking fabrics are extensive in the three midland counties, where the worsted, cotton, and silk are spun by machinery, and by a division of labour in spinning, dyeing, weaving, seaming, pressing, &c. thousands of dozens are made every week, and exported, at low prices, all over the world.

STOMACH. A membraneous bag, situated in the epigastric region, which receives the food from the œsophagus, and is the fundamental animal, to which all the rest is accessary, being of the nature of the hydatid, or polypus, which may be regarded as naked stomachs or primary absorbent systems. Its figure is somewhat oblong and round. It is largest on the left side, and gradually diminishes towards its lower orifice, where it is the least. Its superior orifice, where the œsophagus terminates, is called the *cardia*; the inferior orifice, where the intestine begins, the *pylorus*.

The stomach, like the intestinal canal, is composed of three coats, or membranes:—1. The *outermost*, which is very firm, and forms the peritonæum; 2. the *muscular*, which is very thick, and composed of various muscular fibres; and, 3. the *innermost*, or *villous coat*, which is covered with exhaling and inhaling vessels, and mucus. These coats are connected together by cellular membrane. The glands of the stomach, which separate the mucus, are situated between the villous and muscular coat, in the cellular structure. The nerves of the stomach are very numerous, and come from the eighth pair and intercostal nerves. The lymphatic vessels are distributed throughout the whole substance, and proceed immediately to the thoracic duct.

*Stomachic Bitter.*—Take 4 oz. of the infusion of columbo-root, 4 oz. of the infusion of cascarilla bark, a dr. and a ½ of carbonate of potash. Mix, and take three spoonfuls twice or thrice a day.

*For Stomachic Complaints.*—Take 5 grs. of columbo-root, 5 grs. of rhubarb, and 5 grs. of salt of soda. Mix with cold water, and take the dose a quarter of an hour before dinner, every day, or every second day. If it purge, less soda.

*Or*, take 30 chamomile-flowers, 30 grs. of columbo-root, powdered, and 6 drops of elixir of vitriol. Infuse them in ½ a pint of boiling water in a covered vessel, for an hour; then strain, and take a wine-glass once or twice a-day.

*Or*, take 25 grs. powdered rhubarb, 50 grs. testaceous, or shell-powder, (which is preferable to magnesia); a small wine-glass of brandy, a wine-glass of peppermint-water. Put these in a half-pint phial, sweeten the mixture with two or three lumps of sugar, and fill up the vessel with water. Two table-spoonfuls 3 or 4 times a-day.

*Tincture of Rhubarb*, is an excellent remedy for disorders in the stomach; and the best mode of using it is to take two-spoonfuls of it immediately before going to bed, or soaked in soft bread.

*Or*, take of rhubarb in powder, and of chamomile-flowers in powder, equal quantities. Mix them with treacle, till of a consistency to be made into pills. Take two an hour before dinner.

*Or*, take of aloes one ounce and a half; of mastic half an ounce. Powder these ingredients separately. Mix them in a sufficient quantity of syrup of wormwood to make into a paste. Put three grains in a pill. One or two of the pills to be taken every day, *before dinner is ended*, but not on an empty stomach. Continue the use of them for three months, or longer, if necessary. It is a curious circumstance, that medicine taken in this way acts with tenfold effect, so that a single grain of a cathartic, swallowed in the middle of dinner, is equal in its effects to a full dose at bed-time.—*Sinclair*.

*Stomach Plaster*. Mix oil of mint 1 dr., oil of mace and cinnamon of each half an oz., frankincense 1 oz., and 3 oz. of laudanum. *Or*, 1 ℔. of laudanum, 10 ℔s. of bees'-wax, 8 ℔s. of palm-oil, 5 ℔s. of brown rosin, 4 ℔s. of Burgundy pitch, 2 oz. of oil of mace, 4 drs. of oil of caraways, and 1½ drs. of oil of mint.

STOMACH-PUMP, lately introduced into practice, for removing poisons, &c. from the stomach. It resembles the common small syringe, except that there are two apertures near the end, which, owing to valves in them, opening different ways, become what are called a *sucking* and a *forcing* passage. When the object is to extract from the stomach, the pump is worked, while its sucking orifice is in connexion with an elastic tube passed into the stomach; and the discharged matter escapes by the forcing orifice. When it is desired, on the contrary, to throw cleansing water or other liquid into the stomach, the connexion of the apertures and the tubes is reversed. A simple tube will, in many cases, answer the purpose. If the tube be introduced, and the body of the patient be so placed that the tube forms a downward channel from the stomach, all fluid matter will escape from the stomach by it, as water escapes from a funnel by its pipe; and, if the outer end of the tube be kept immersed in liquid, there will be, during the discharge, a syphon action of considerable force. On changing the posture of the body, water may be poured in through the same tube to wash the stomach. Such a tube, made long enough, might, if desired, be rendered a complete bent syphon, the necessary preliminary suction being made by a syringe, or by the mouth, through an intervening vessel.

STONE AND GRAVEL, is a disease of the kidneys, sometimes of morbid secretions, and sometimes of additions to secretions of lithic acid found in human urine. White sediment is phosphate of lime or magnesia, but reddish-brown is lithic acid, an acid peculiar to man. For white gravel, citric acid in doses of 10 or 20 grains, and acid fruits and legumes, are the true remedy, and alkalies and ferments a cause; except in effervescing draughts, made with potash and citric acid. The red gravel of lithic acid, if voided or deposited, is checked by carbonate of potash or soda, or ammonia, with occasional magnesia and aperients. But Wollaston prescribes vegetable diet as the only sure remedy, and as far more efficacious than any course of alkalies. Stones in the kidneys are either lithic, oxalic, or cystic acid, and pass into the bladder with painful symptoms. There the nucleus of lithic acid receives coats of the phosphates, and it appears that arthritic or gouty calculi are lithate of soda. As no other animal secretes lithic acid, the germ of this terrible disorder, the peculiarity is referred by Scheele, Wollaston, Tennant, Ure, Brande, Berzelius, &c. to animal food and fermented liquors. The same authorities decide against the possibility of dissolution by medicine or injections.

*Stone-breaking Machine*.—This consists of a rotatory steam-engine attached to a machine similar to a bone-mill, but considerably stronger. It breaks the stones, to cover the road, at the astonishing rate of 70 or 80 tons in 10 hours. It is mounted on wheels, so as to be removed to any part of the road. But, as it does not discriminate, so it powders many tons of stones, or makes them too small.

The stone broken for the streets of London, or the adjacent roads, is brought chiefly from Guernsey. The breaking employs vast numbers of men, at 3*s*. per cubic yard, and a man breaks rather more than half a yard per day.

*Stone Ware*, is four clay, and one of fine sand, and, when burnt, will strike fire with steel.—*See* POTTERY, &c.

STORAX; a gum-resin, obtained by incisions in the branches of a small tree which grows wild in the countries about the Mediterranean.

STOVES differ from fire-places, by enclosing the fire, so as to exclude it from sight, the heat being given through the material of the stove.

The common Dutch stove is an iron box, of an oblong square form, intended to stand in the middle of a room. The air is admitted to the fire, through a small opening in the door, and the smoke passes off through a narrow funnel. Being insulated, and detached from the walls of the room, a greater part of the heat produced by the combustion is saved, and the radiated heat being thrown into the walls of the stove, they become hot, and, in their turn, radiate heat on all sides to the room. The conducted heat is also received by successive portions of the air of the room, which pass in contact with the stove.

The disadvantages of these stoves are, that houses containing them are never well ventilated. A dryness of the air is also produced, which is oppressive, so that it often becomes necessary to place an open vessel of water on the stove, the evaporation of which may supply moisture to the atmosphere. Stoves are, however, very useful in large rooms, which are not inhabited constantly; as halls, churches, &c.

The Swedish and Russian stoves are small furnaces, with a very circuitous smoke flue. In principle, they resemble a common stove, with a funnel bent round and round, until it has performed a great number of turns or revolutions, before it enters the chimney. It differs, however, in being wholly enclosed in a large box of stone or brickwork, which is intersected with air-pipes. In operation, it communicates heat more slowly, being longer in becoming hot, and also slower in becoming cold, than the common stove.

Russian stoves are usually provided with a damper, or valve, at top, which is used to close the funnel or passage, when the smoke has ceased to ascend. Its operation, however, is highly pernicious, since burning coals, when they have ceased to smoke, always give out carbonic acid in large quantities.

A large suite of apartments may be sufficiently heated by a single stove in a cellar. The stove, for this purpose, should be entirely enclosed in a detached brick chamber, the wall of which should be double, that it may be a better non-conductor of heat; but the space between the brick chamber and stove should not exceed an inch. In the apparatus of the Derbyshire and Wakefield infirmaries, the whole of the air is repeatedly conducted, by numerous pipes, within half an inch of the stove and its cockle. For the supply of fuel, the same door which opens into the chamber should open also into the stove, that there may never be any communication with the air of the cellar. A current of external air should be brought down by a separate passage, and delivered under the stove. A part of this air is admitted to supply the combustion; the rest passes upward in the cavity between the hot stove and the wall of the brick chamber, and, after becoming thoroughly heated, is conducted through passages, in which its levity causes it to ascend, and be delivered into any apartment of the house. Different branches being established from the main pipe, and commanded by valves or shutters, the hot air can be distributed, at pleasure, to any one or more rooms at a time. The rooms, while they are heated, are also ventilated, for the air which is continually brought in by the warm pipes displaces that which was previously in the room, and the air blows out at the crevices and key-holes, instead of blowing in, as it does in rooms with fire-places.

STOUGHTON'S ELIXIR.—In 6 gallons of water, and 6 of alcohol, infuse 36 oz. of gentian-root, 16 oz. of snake-root, 24 oz. of orange-peel, and 4 oz. of calamus arom.

STORE-ROOM, is a family depository for such articles of household consumption as are in continual request, and may be purchased in quantities, at times when cheapest, most in season, or best, to be ready at hand when wanted.

*Soap* is better for keeping; indeed, it should not be used when newly made. The cakes should be cut with a wire or string, into oblong squares, and laid up, on a dry shelf, a little distance apart, and across each other, so as to admit the air to harden them.

*Candles*, made in cold weather, are best. If kept packed in a chest, they are better for keeping eight or ten months, and may be kept well, if necessary, for two years.

*Starch* should be kept in a dry warm place, and, if closely covered, will be good as long as may be necessary.

*Loaf-Sugar* should be kept tied up in paper, and hung in a dry place. Brown-sugar should be kept covered up, and in a moderately-dry place.

*Sweetmeats*, *Preserves*, &c. must be carefully kept from the air, and in a very dry place.

*Tea*, *Coffee*, *Chocolate*, *Dried Fruits*, and, generally, all kinds of grocery and condiments, require to be kept dry and free from air.

The various kinds of seeds and rice, pearl-barley, oatmeal, &c. must be kept in a dry place, and be covered close, to preserve them from insects.

*Bread* is best kept in an earthern pan with a cover. A loaf should not be cut till it is a day old.

Writing and other papers, that are constantly wanted, should be bought by the ream or bundle, and kept dry.

*Apples* should be spread, separately, on clean dry straw, on a dry upper floor, and care must be taken to preserve them from frost. A clean canvas cloth over them will answer the purpose.

*Pears* should be hung up, singly, by the stalk, in a dry place.

*Grapes* should be gathered before they are ripe, and may also be preserved hung up in single bunches the same way; or, they may be kept in saw-dust, in boxes with covers, to exclude the air, every bunch being laid apart.

*Oranges and Lemons*, if bought when cheapest, may be preserved a long time, packed in fine, dried sand, with their stems upwards, and kept from the air.

*Fresh Meat*, *Poultry*, *Fish*, &c. should be kept in a cool, airy place.

*All Salted and Dried Meats*, hams, tongues, &c. should be tied up in strong paper, and must be kept in a cold, dry place, (not in the kitchen) else they will become musty and rancid.

*Green Vegetables* should be kept on a damp stone floor, and excluded from the air, by a damp cloth over them.

*Carrots*, *Parsnips*, and *Beet-roots*, must be kept in layers of dry sand for winter use. Neither these, nor potatoes, should be washed till wanted.

*Potatoes* must be carefully covered, to protect them from frost, in winter.

*Onions* should be tied in traces, and hung up in a cold dry place. If the root of each onion be seared, it can never grow.

*Parsley* should be cut close to the root, and dried in a warm room.

*Truffles*, *Morels*, &c. must be kept in bags in a dry place.—*Adams.*

STRAMONIUM, or Thorn-Apple, is a well-known plant in our hedges and ditches, and has much celebrity as a substitute for tobacco, in relieving spasmodic asthma. It is also powerful as a narcotic and stimulant, and used in epilepsy, and as a cataplasm in inflammatory swellings.

*Tincture of Stramonium.* — In one pint of alcohol infuse two ounces of stramonium seeds. The dose of eight drops is superior to laudanum.

Stramonium is a species of *datura*, and belongs to the *solaneæ*, the same natural family as the tobacco and nightshade. It is one of the most dangerous of narcotic poisons; and, when taken internally, produces vertigo and torpor.

STRATA.—These, beginning at the surface and descending, are loam, sand, and gravel, peat, bog-iron ore, calctuff, or porous carbonate of lime, calc-sinter, or stalactites, also carbonate of lime, called alluvial.

The next, or floetz, parallel rocks, are the new trap, the coal, the older trap, the chalk, the rock salt, the third and second limestone, the second gypsum, the second sandstone, the older gypsum, the older limestone, and the old red sandstone.

We then come to the five transition rocks of gypsum, slate, greywaike, and slate, trap, and transition limestone.

The fourteen primitive are granite, or detritus of granite, in its quartz, felspar, and mica, with three slates, one limestone, and one gypsum.

They are otherwise divided into 1, the *superiour*, of sand and clay, above the chalk.

2. The *super-medial*, of chalk, sand, and clay, oolites, or calcareous freestone or Portland stone, limestone and clays, or lias, new red sandstone, magnesian limestone.

3. *Medial coals*, limestone, and old red sandstone.

4. *Sub-medial*, slates, &c.

5. *Inferiour*, mica slate, gneiss, granite, &c.

All silex, argil, calx, but denser and denser as we descend. In the series there are five slate or argillaceous formations, five limestone or calcareous, four gypsum, and three trap. Silex commences in the quartz of the granite; then there is quartz rock, four sandstone, millstone grit, and coal grit. In the fourteen primitive are no organic remains; in the transition corals, &c.; the coals, &c. present vegetables; and in the thin lias layers commence animals of superior character, upward.

Strata are of such variable thickness that a uniform bed is often 1, 2, or 300 feet, while others are but a few inches, and some not one inch. Some appear to be products of single tides, others of spring-tides, and others are results of periods and prolonged cycles of the producing causes. The separation of the beds is called the parting. The vertical sections are called backs and cutters; and the partings, the backs and cutters, form the sides of the mass of a stratum.—*See* Dykes, Ditches, &c.

Strata scarcely ever lie horizontal, but incline or *dip* to the east, west, or other point of the horizon, the opposite point being called the *rise*. In rising, they ascend to the surface, and their display there is called their *cropping*.

Above the granite the strata are believed to be mechanically formed, and confused by repeated disturbance. Specific gravity is, therefore, no general test of depth—mechanical structure of parts being sufficient to sustain incumbent pressure; yet the primary and lower strata are, on the whole, far denser than the new and superficial.

STRAW.–The ground *straw* of wheat, and other grains, and of hay, trefoil, lucern, saintfoin, &c. is a complete substitute for bran. Sheep and lambs consume it with avidity, and it may be given to all other graminivorous animals as grateful and substantial food. It consists in simply grinding the straw; and we know that the mere chopping of straw adds greatly to its nutritive powers, by facilitating mastication and digestion; but, a more perfect comminution of its parts produces a corresponding effect, and extends widely the uses of straw, as a means of feeding domestic animals.

STRAW-HATS.—In this manufacture the culms of several kinds of grasses are used. Leghorn straw is the culm of a peculiar sort of wheat sown on poor soils, and cut green. The straw is cut at the joints; and the outer covering being removed, it is sorted of equal sizes, and made up into bundles of eight or ten inches in length, and a foot in circumference. The bundles are afterwards to be placed on their edges, for the purpose of bleaching, in a box which is sufficiently close to prevent the evaporation of smoke. In the middle of the box is an earthern dish, containing brimstone, broken in small pieces: this is set on fire, and the box covered over and kept in the open air several hours.

It is the business of one person to split and select the straws for 50 others, who are braiders.

The straws, when split, are termed *splints*, of which each worker has a certain quantity; on one end is wrapped a linen cloth, and they are held under the arm, and drawn out as wanted. Plaiters should be taught to use their second fingers and thumbs, instead of the forefingers, which are often required to assist in turning the splints, and thus much facilitate the platting; and they should be cautioned against wetting the splints too much.

The finest hats are made near Leghorn. The manufactures in Bedfordshire are of a fine quality, and much straw is imported from Tuscany. In the English plait, the straws are flattened in a hand-mill, previous to working; but, in the Leghorn, the pressure is applied after the plaiting is made.

Straw-hats are made from the top joint of the wheat-straw grown in the poor calcareous soils, near Dunstable and Luton, where the manufacture employs thousands of women and children.

STRAWBERRY, one of the most wholesome and most delicious of our fruits. It is easily cultivated, and numerous varieties have been produced; some of great excellence have been obtained recently. It forces well, and, with a little trouble in choosing a succession of sorts, may be had almost every month in the year. They must, till the fruit is set, have copious supplies of water. The row culture is most convenient, and frequent renewal ensures vigorous plants and large fruit.

Strawberries are propagated by runners, which are young plants that proceed abundantly from the old ones. They may be planted about a foot apart, or in rows of about two feet apart; or in beds of about three or four rows, about a foot distance. They may be planted in the autumn, or early in the spring. They will be in good bearing in two years, and will continue good for four or five years. Keen's seedling is a fine early strawberry, and a prodigious bearer. The old pine is esteemed for its flavour, and the scarlet and Chinese are good bearers. They require plentiful watering, if the weather is dry.

*Strawberry Jelly.*—Boil together two lbs. of sugar, and four lbs. of strawberry-juice.

STRENGTHENING PLASTER.—Mix 1 lb. of diachylon with ½ a lb. of frankincense, and 3 oz. of gum-dragon. *Or*, 28 lbs. of diachylon, 8 lbs. of frankincense, and 1 lb. of bole.

STRONTITES; a peculiar earth, first noticed in a mineral brought from Strontian, in Argyleshire, is of a grayish-white colour, possesses a pungent, acrid taste, and, when powdered in a mortar, the dust that rises irritates the lungs and nostrils. The solutions convert vegetable blues to green, and it tinges the flame of a candle of a beautiful red colour. Sir H. Davy decomposed it at the galvanic poles, and gave the base the name of *strontium*, which is a white solid, heavier than water, and when exposed to the air, or when thrown into water, it rapidly absorbs oxygen, and is reconverted into strontian. Strontium being, in fact, an alkali, deoxydized by the radiation of the galvanic shock, and oxydized again in air or water.

The beautiful red fire, so frequently used at the theatres, is composed of 40 parts of dry nitrate of strontites, 13 parts of finely-powdered sulphur, 5 parts of chlorate of potash, and 4 parts of sulphuret of antimony, by rubbing them together on paper.

STRUVE'S LOTION, for the hooping-cough, consists of one grain of tartarized antimony in two fluid ounces of water, and one fluid ounce of tincture of cantharides.

STRYCHNIA, extracted from nux-vomica, next to hydrocyanic, or Prussic acid, is the most rapid known poison. The 8th of a grain killed a dog, and the 6th another in two minutes. It is the poison of the upas-tree of Java; nevertheless, avarice often adds it to arrack, and to malt-liquor, to make them strong and heady. Many of the vulgar like that beer best, of which the smallest quantity makes them drunk.

STUFF-HATS.—The body of hats is composed of various *stuffs*, in any proportion; commonly with the addition of a little fine wool, and sometimes a small quantity of silk.

*Felt-making* consists in a method of working up wool or hair into a species of cloth, independently of either spinning or weaving. It depends on that conformation of all animal hairs and wool, which disposes them to unite, by their speculæ, with each other, so as to produce a firm compact substance.

The wools are washed and carded, and, when too long, cut to a moderate length with a chopping-knife or hatchet, on a wooden block. It is then kept in the digesting heat of a stove all night.

In felting, the object is, to obtain the most complete separation of the fibres, and to dispose a layer of them in every possible direction with regard to each other, by bowing. For this purpose, a platform of wood, about four feet wide, is erected against the wall of the workshop, called the *bow-garrat*, and divided by side partitions of uniform width, at each end of which is a window. These partitions, called *hurdles*, are for the convenience of the workmen. To each hurdle is suspended a bow, by means of a small cord fixed to the ceiling, or any other convenient place, consisting of a pole about seven feet long, generally made of yellow deal wood, to which are fixed two bridges of hard wood. To the upper part of the bow is fastened a cat-gut line, or bow-string of considerable length, and twisted round the pole.

The operation of bowing commences by placing the materials towards the left hand of the hurdle. By repeated strokes the whole is worked. When about one-third part is thus bowed, it is formed by the hands into an oval figure, ending in acute angles, called a *batt*. The batt remains to be *hardened* by a slight pressure of the hands for a short time, so as to connect it together sufficiently to bear careful handling. Another batt is then formed of the same dimensions; and of the remaining third part, two smaller batts.

A wet cloth is now folded, so as to form a triangle, and laid on one of the batts. The extremities, with a small portion of the upper part, is then folded over the cloth, and the edges, meeting over each other, form a conical cap.

The *bason* is a circular piece of iron, and is laid over a hole in a plank, under which is a small grating, fitted to the plank for this purpose. The prepared *cap* is then laid on the warm iron, and the process of felting carried on by folding, pressing, and sprinkling it continually with water, so that it soon acquires firmness, and contracts in dimensions.

The hood now consists of a soft spongy kind of stuff, and its texture is loose and imperfect, but, to effect a closer cohesion of the hairs with each other, and obtain the required degree of consistence, it undergoes a kind of fulling, by being boiled in an iron boiler, in a mixture of about one part urine to six parts of soft water, from six to eight hours. The felting is completed by working or planking at a water-bath.

*Working* or *Planking* is performed at an apparatus called a *battery*, which consists of a certain number of wooden planks, united in the form of the frustrum of a pyramid, supported by stone or brick-work, and meeting at the bottom in a *kettle*, under which is a fire-place. The number of planks is usually from five to seven; and, according to the number made use of, it is called a five, six, or seven-room battery, &c. Each plank is from two to three feet broad at the upper edge, and about two feet deep. The kettle is kept full of soft water, nearly boiling. To facilitate the felting, it is found necessary to add some softening material to the bath, and oatmeal is almost universally used.

The operation commences by dipping the hood in the bath, and gently rolling it in various directions, preserving a degree of regularity. It is necessary to be careful at first to turn the hood inside outwards, and to shift the position of its sides frequently, to prevent their felting together. By working a short time in this way, the article will be found to have acquired a firmer texture, and contracted rapidly in its dimensions. The workman then applies leathern gloves to the palms of his hands, or flat pieces of stout leather, to defend them, in some degree, from the heat of the water, and continues to dip it oftener, and roll it harder than before. It contracts in its dimensions, and acquires a degree of firmness in substance. To prevent undue contraction, when it is sufficiently shrunk, and yet not worked to a sufficient degree of consistency, a small roller of wood is made use of; over this the edges of the felt are turned, and the whole is rolled in various directions with the warping-pin, enclosed by the surrounding felt, at the same time continuing to dip it often in the bath.

The intended hat, after the preceding operation, still possesses the conical figure first given it, capable, with a moderate degree of force, of being extended in every way. The next thing to be done is to give it the required form by blocking. For this purpose the edge of the hood is turned up about one and a half or two inches; the point is then indented with the fingers, and the hood turned over, so as to produce a second inner fold, about the same depth. From three to five folds are thus formed, and the whole bears the appearance of a flat piece, consisting of a number of concentric circles, or wave-like undulations. This is laid upon the plank, and the workman, keeping it wet with warm-water, extends the central point with the fingers of his right hand, at the same time pressing it down with the left, and turning it round on the plank, till a flat portion is formed, equal to the intended crown of the hat. The flat part is then placed on a block, and the remainder pulled down with the hands round its sides, and a string tied tight round; it is forced down to the bottom of the block with a wooden or copper stamper, which forms the band.

Common wool hats, or plain *cordies*,

are of one uniform contexture throughout; but ingenuity places the best side outwards. This is done by laying on the body of the hat, when partly felted, a finer and more valuable material, in the same direction it has when on the back of the animal.

For covering wool hats, the articles are cod-wool and camels' hair; the former of which, after washing and carding, is boiled about an hour and a half in one part urine to about twelve or fourteen parts of water. The hats covered in this way are bowed, basoned, and boiled in the usual manner; the common materials being used only in less quantity, proportioned to the addition intended to be made.

A thin layer of the prepared cod-wool, with or without the addition of hair, is then *bowed* for each side of the triangular hood, so as just to meet at the edges; and another piece to go all round on the inside, to the depth of the intended brim. The pieces are laid on the principal stuff or body of the hat, and worked on by basoning, in the manner already described; the hairs assuming a motion towards the root, uniformly fix themselves in that direction, leaving the extremities outward which constitute the required nap.

Next to plain hats succeed *the tips;* these have only a nap sufficient to cover the crown, and reach a short way down the sides. The second class are *tips* and *naps;* these, as well as a cod-wool tip, have a nap of the same on the under side of the brim. And lastly succeed the *covers;* a good cover takes about two ounces of cod-wool, and a hair cover about half an ounce of hair, in addition to the cod-wool.

*Plated Hats* are a middle class, between cordies and stuffs, designed as a substitute for the latter. To effect this purpose, the different kinds of stuff are plated on wool bodies. The wool body, after it is boiled in about one part urine to three parts water, and has been worked sufficiently to complete the felting, is laid over a hair cloth on the plank; the nap is then laid on the surface, sprinkled with a brush, and patted down. A layer of old stuff, or stuff which has its properties of felting destroyed, and carded cotton, or either of these separately, is bowed and laid on in the same manner, commonly mixed with a small portion of napping, and sometimes another layer is added.

It is then slightly rolled a short time in the hair cloth, and the nap is fixed on by the operation of shaking and patting with the stopping-brush.

The cotton and old stuff, during the operation, sticking on the body of the hat by means of the hot liquor, preserve the nap from flying off; at the same time, by enabling it to hold a greater body of the fluid, the work is facilitated, and the nap is also preserved from the continued action of the brush.

When the nap is completely fastened, which will be in about half an hour, the cotton and old stuff are loosened by striking with a flat stick, and continuing the shaking. In a short time, they will appear in a loose flake over the surface, which is taken off with the fingers, whilst the nap remains fixed by the roots in the substance of the felt; the cotton and old stuff are dried and preserved for future use. In plating, as the bodies are first boiled, and as the nap laid on is of a soft smooth nature, nothing is made use of in the kettle but clean water.

The colour of hats is black, drab, and white. White hats have a nap of rabbits'-fur, selected from white skins. Drab hats are also made of stuffs of the natural colour, assorted for that purpose. In dyeing black, the articles in general use are logwood, copperas, and verdigris. For dyeing common *cordie* hats, the general proportions for twelve dozen are, about 24 lbs. of logwood, 7 of copperas, and a $\frac{1}{4}$ of a lb. of verdigris. The logwood is chipped, and left in the boiler to soak the preceding night: part of the copperas and verdigris is then added, and boiled with the logwood. The hats are each fastened on a block, with a string tied round the band, and boiled in the liquor; sometimes turning those nearest the surface, and placing a weight upon them, to keep them under the liquor. After boiling about an hour they are taken out, and exposed to the air, while a fresh quantity is boiled in the kettle the same time as before. This boiling and airing is repeated several times, according to the strength of the dye, the perfection required, or the nature of the materials to be dyed.

Common hats, that are easily dyed, have generally two suits only; best hats, from three to four. On account of the high price of verdigris, sulphate of copper, or blue vitriol, is frequently made use of in dyeing common hats in a larger proportion; or a mixture of about equal parts of each. But those dyed with verdigris only have the brightest appearance after finishing. In France, 100 lbs. of logwood, 12 lbs. of gum, and 6 lbs. of galls, are boiled in water for some hours, when 6 lbs. of verdigris and 10 lbs. of green vitriol are added; and this liquor is kept simmering, a little below boiling.

As soft water is essential in dyeing hats, hard water may be prepared for the purpose, by putting five bushels of bran into two hogsheads of water, and the water of a large boiler being poured, while nearly boiling, into the vessel containing the hard water and bran; fermentation commences, and soft water is ready in 24 hours.

After hats are dried, the next operation they undergo is that of stiffening. For the common purposes of stiffening, glue and vinegar dregs, beer grounds, or dregs from the distilleries, are the articles made use of. The hat to be stiffened is put into the crown of a large hat, which is felted and blocked for the purpose, and has the crown slit so as to admit the hat readily to a sufficient depth. These are then placed over the hole of a plank on which the brims are supported. The dregs are then applied, first warm, with a brush similar to a large painting-brush on the inside of the crown only.

The dregs are made use of, as they are the cheapest mucilage, and give sufficient firmness to the hat, at the same time preventing the glue from penetrating through the surface.

After this is dry, glue is applied to the crown in the same manner, and made in the proportion of about one ℔. of glue to three pints of water. After it is laid on with the brush, it is well rubbed round with the hand; for which purpose, it is found expedient to employ a second person, who receives the hat of the first person, as fast as the glue is laid on with the brush.

In stiffening a quantity of hats, the crowns only are thus attended to in the first place. In common hats, the grounds are frequently mixed with the glue, and laid on at the same time. The brims are next stiffened with a common soft brush, and glue only, which is applied to the under side. This is well worked into the body of the felt with the hand, and the hats are placed in a stove to dry. When dry, the nap on the under side of the brim will be glued down to the felt; this is removed from the surface by scouring it with a brush, and a quantity of warm soap-suds, which are pressed out of the nap by the blunt edge of a wooden or copper stamper. Ladies' light hats are stiffened with starch, or flour-paste only.

In France, gum-arabic, and Flanders, glue, are employed for tho purpose of stiffening, or a solution of glue in a strong decoction of linseed.

As glue is subject to the action of the atmosphere, glued hats are not waterproof. One of the methods is that of balling. A ball is formed by melting about 3 parts resin, 4 parts bees'-wax, and 2 parts mutton suet; and frequently rubbed over the inside part of the hat while planking, particularly over that part which is to form the band, and, after balling, the hats are stiffened with glue in the usual manner.

For water-proof stiffening, particularly for best hats, nothing has so completely answered, as stiffening with a solution of caoutchouc, as sold in Agar-street.

The dry hat, after stiffening and water-proofing, is very rigid, and of an irregular figure; preparatory to *finishing*, therefore, it requires to be blocked into a regular shape. For this purpose, it is necessary to soften the glue, which is done by steam. A hot iron is placed within a circular wooden frame, on which a wet cloth is thrown; the crown of the hat is then laid over the rising steam, whilst the brim rests on the frame, and thus it is soon rendered sufficiently soft to receive the impression from the block, of the intended size and shape. By the use of a hot iron, generally weighing from 20 to 25 lbs. a small card, brushes, &c. with the addition of water, the nap has the requisite direction given it, and receives its smoothness and polish.

The instrument generally made use of for cutting the brims of round hats, is merely a small worn-out card. The hat is put in shape by curling the edges with the iron, over a small rope for that purpose, stretching the hat out in oval form, by placing a screw, or common stick, across, and forming the brim with the hands whilst it is warm. The coarse hairs are picked out of the fine hats with a pair of steel prickers, and then given to be lined and bound.

STYPTICS, are preparations of iron-filings, with tartar and brandy; or alcohol and sulphate of iron. They stop bleeding by application, and, in some cases, arrest bleeding by the œsophagus, mistaken for rupture of the lungs.

SUB-CARBONATE OF POTASH, better known as salt of tartar, or salt of wormwood, is a very deliquescent powder. It is 1 acid, 1 potash, and soluble in double the weight of water. It combines with oils, forming soaps, and is used for saline draughts.

SUDORIFICS, or DIAPHORETICS, are medicines or means which produce the necessary evaporation from the skin, or action of the skin. They consist of ammonia, guaiacum, antimony, warm-bathing, friction, &c. But brisk exercise which leads to increased respiration, and continued till perspiration takes place, is the most efficacious. The galvanic action of the system, which is the continuous principle of life, demands that the lungs and skin should be in correllative action and reaction. Ono fixes the principle of acidity, and the other fixes the principle of alkalinity, in a variety which, in other forms, is called positive and negative electricity.

SUGAR, is a constituent of many vegetables, and is obtained in immense quantities from the sugar-cane of the East and West Indies, from the maple of North America, the beets of Germany and France, from all starch, &c.

The sugar-cane has a jointed root, and sends up jointed stems 8 or 10 feet high, with a leaf to each joint 3 or 4 feet long, like a blade of grass. The flowers are in panicles, 2 or 3 feet long. It is propagated by cuttings near the top, and laid horizontally. It ripens in 15 or 16 months, and yields 4 or 5 crops of shoots. The canes are cut for sugar in 9 or 10 months, when about 8 or 9 feet, and dry and brittle. They are crushed between three upright iron cylinders, the juice received in leaden vessels, and thence passed to a copper clarifier, mixed with a little lime and exposed to a heat of 140°. A scum forms, and the clear liquor beneath is drawn off, and reduced by boiling in three or four coppers. It is then passed into shallow wooden coolers, where it crystallizes and separates from the molasses. It is then put in casks, with plaintain-stalks in holes at the bottom, and the molasses draining through these, the residue is muscovado sugar.

It is then refined into loaf-sugar, by boiling it in lime-water in a copper, closed at the top, and exhausted of air, on Howard's plan, so as to evaporate with low heat, and is clarified by a series of canvas filters, in combination with a solution of alum and quicklime. The loaves are purified in the last process without clay, and in the first the nauseating intermixture of bullocks' blood is avoided.

Another plan, Wilson's, is adopted, of boiling every 112 lbs. of sugar with 4 oz. of a solution of sulphate of zinc, which combines with the impurities. A filtering apparatus is then employed, and the syrup boiled, by the heat of hot oil, in copper or tin tubes.

Mr. M. Robinson has patented some improvements in the process of making and purifying sugars. He applies to the juice a saturated mixture of alum and lime, in the proportion of two pounds of the mixture to a hundred gallons of the juice. These being intimately mixed, the acid is to be neutralized by the application of milk of lime, in the proportion of three pounds to a hundred gallons. If there be an excess of acid, it will be discovered by the application of the test-paper usually employed by chemists to detect acids, and more milk of lime must be added: and if there be an excess of alkali, it may be discovered by the application of the test-paper used for detecting alkalies, and more juice must be added. When the mixture ceases to effect either the test for acid or alkali, the impurities will be precipitated, and may thus be separated; and the juice thus purified is to be subjected to the usual mode of clarification and concentration.

Pure raw sugar is now obtained direct from the sugar-cane, without having undergone any subsequent process of decolorization or refining, prepared by effecting the last stages of the concentration of the cane-juice in a vacuum, at a temperature insufficient to produce any chemical changes in its constituent parts. By this improved and scientific process of manufacture, no molasses, or uncrystalizable sugar is formed, and there is, hence, an increase in the quantity of sugar obtained of 25 per cent. This establishes the fact, that molasses are not an *educt* of the cane, but merely a product of the former operation, from the intense and long continued degree of heat employed in the processes. The sugar, thus obtained, is in perfect, pure, transparent, granular crystals, developing the true crystalline form of the sugar, and being entirely free from the least portion of uncrystallizable sugar or colouring matter. The new process is now in complete and successful operation in eight estates in Demerara. From the results of the first trials, the introduction of the present improved process cannot fail soon to become general, and the product is much approved in the European market.

The best *sugar-canes* yield about half their original weight of saccharine liquor, which boiled affords sugar, in grains and in oblique four-sided prismatic crystals. By refining, they are converted into white loaf-sugar. It melts at 250°, and at a red-heat inflames and explodes. Lime decomposes it and renders it a gum. Its components are $42\frac{1}{4}$ carbon, $6\frac{1}{4}$ hydrogen, and 51 oxygen, whether from cane, beet, maple, or carrot.

The importations, in 1831, were 5 millions of cwts. in Great Britain, of which above $3\frac{3}{4}$ came from the West Indies; besides, nearly 8 millions gallons of its spirit, rum. But $1\frac{1}{4}$ of one and $2\frac{3}{8}$ths of the other were re-exported.

The sugar of grapes, figs, starch, mushrooms, manna, liquorice, honey, &c. are different in chemical properties and flavour.

That of *grapes* is produced by neutralizing the acid with chalk, and boiling the clear liquor with white of eggs, down to 1·32. In two or three days the sugar deposits in grains. It is whitened by digesting with ivory-black.

That of *figs* is obtained by solution in boiling alcohol.

Sugar may be made from *honey*, by melting it, and adding powdered egg-shells till effervescence ceases. Skim it and filter, set it to crystallize, and then wash the crystals with alcohol. By adopting *Nutt's hives*, the sugar, from this source, might be greatly increased, and every cottager enabled to make his own sugar.

*Sugar from potatoes.*—Every person who grows potatoes may manufacture sugar from them, at the rate of 11 lbs. of sugar from 100 lbs. of potatoes. The white yields only 4 lbs. in 100 lbs.

*Sugar of Starch.*—Expose starch to heat till it becomes yellow, and soluble in cold water; a spontaneous decomposition then takes place, and half the weight of the starch is sugar, the rest being a gummy substance. Sulphuric acid also converts starch into sugar. Weinrich says, that from one to two parts of sulphuric acid for each 100 parts of potato starch is sufficient, if the heat applied be a few degrees above 212° Fahr.; and also that then two or three hours are sufficient to give crystallizable sugar. He applies heat in wooden vessels by means of steam.

SUGAR OF LEAD, OR ACETATE OF LEAD, consists of 1 acetic acid, and 1 oxide of lead. It is insidiously formed in many manufactories, and by the use of leaden pipes for liquids containing any acidulous or oxydated liquor, and it combines from paints made of it with the oxygen of the air, so as to affect the lungs and blood of painters, and cause dry belly-ache, painters' cholic, pulmonary consumption, &c. &c. Astringents combine with it; and, hence, Dr. Paris, who ascribes the deleterious properties of new rum to lead combined in making it in the works, says, that oak casks in 12 months abstract it from the liquid.

*Sugar of lead ointment.*—In 8 oz. of olive-oil mix 2 drs. of acetate of lead, and $1\frac{1}{4}$ oz. of white wax.

SULPHUR, an ambiguous and very combustible substance, usually called an element, but a palpable compound. There are four gases, weighing 29·65 to the 100 cubic inches, and sulphurous gas weighs 33·888, the same as oxygen; then 2 hydrogen 4·236, added to either of the 4, makes the exact weight of this gas; and 1 of hydrogen added makes sulphuretted hydrogen 36·006, whose acid qualities and power of combining with alkalies and oxides, in hydro-sulphurets, proves undeniably that the *base* sulphur is a compound. Whatever burns cannot be an element, since burning is evidence that it parts with hydrogen, whose union with oxygen is burning. In fact, the exact weight of sulphur may be made by adding half a volume of carbonic acid 23·298 to 5 volumes of hydrogen 10·590, and we then get exactly 33·888 in substances such as may be supposed to form sulphur, and to accord with all its phenomena of burning, choking, smelling, and acidifying. Its volcanic origin and its generation in veins exactly accord with this theory.

Davy imagined sulphur to be oxygen and hydrogen with an unknown base. Sulphurets are compounds, which combine by fusion with metals, oxides, &c. When water is united it is called an hydrogureted sulphuret, since the hydrogen of the water is combined.

Sulphur is regarded by Dr. Paris as a triple compound of oxygen, hydrogen, and an unknown base. This is more rational than considering that a simple substance which, in readily burning, affords so abundant a supply of hydrogen.

Sulphur occurs abundantly in nature, both crystallized and massive. *Volcanic* sulphur appears in the shape of crusts, superficial coatings, stalactites, or loose mealy masses, and consists generally of columnar particles of composition, not unfrequently terminating in crystalline points.

*Common* sulphur has been further divided into *compact* and *earthy*, the last of which comprehends those varieties which, on account of the smallness of the individuals in the granular compositions, appear as a mealy powder.

Sulphur is principally met with in beds of gypsum, or in the accompanying strata of clay. It also occurs with copper pyrites, galena, and orpiment. It is deposited from several springs.

Sulphur, in a state of purity, is destitute of odour, and of a weak, though perceptible taste. It is a non-conductor of electricity, and of course becomes electric by friction. The specific gravity of roll varies from 1·97 to 2 00.

Fused sulphur begins to crystallize between 226° and 228°; between 230° and 284°, it is as liquid as a clear varnish, and of an amber colour. But at about 320° it begins to thicken, and acquires a red colour, and on increasing the heat, it becomes so thick that it will not pour. This effect is most marked between 428° and 572°; the colour is then a red brown. From 572° to the boiling point it becomes thinner, but never so fluid again as at 248°; nevertheless, the deep red-brown colour continues till it boils.

When the most fluid, if suddenly cooled it becomes brittle; but thickened sulphur cooled, remains soft, and more soft as the temperature has been higher. At 230° it is very liquid and yellow; but cooled suddenly, by immersion in water, it becomes very friable. At 374° it is thick, and of an orange colour; but by cooling becomes at first soft and transparent, but soon friable and of the ordinary appearance. At 428° it is red and viscid; and, when cooled, is soft, transparent, and of an amber colour. At the boiling point it is of a deep brown-red colour; and, when cooled, very soft, transparent, and of a red-brown colour. The only precaution necessary is, to have abundance of water, and divide the sulphur into small drops or portions, that the cooling may be rapid. If poured in a mass, the interior cools slowly, and acquires the ordinary hard state. When the experiment is well made at 446°, the sulphur may be drawn into threads as fine as a hair, and many feet.

Sulphur combines with 100 parts of iron as 57·1, and double called pyrites, brown and yellow. With tin as 27·1 and double. With mercury 8·2 and double. With lead as 15·384 and double. With copper 25, and silver 14·544.

Sulphur forms no less than 15 known acids. Its sulphurous acid, of 1 sulphur and 2 oxygen, form an extensive class of sulphate salts. Its sulphuric acid, of 1 sulphur and 3 oxygen (vitriol) forms all the sulphates. Other compounds are 1 and 1, and 2 sulphur, 1 oxygen, and 2 and 5 oxygen.

Oxygen and metals form oxides, and chlorine, bromine, &c. with the same, form chlorides, bromides, &c. The term chloride may be used, as more brief than its equivalent, oxymuriatic acid, but for no better reason than brevity.

Sulphuric acid, in its strongest form, is sulphur 30, oxygen 45, water 17; and it combines with water with such avidity as to generate great heat, and exposed will in time imbibe 7 times its own weight. It distils unaltered. Diluted it freezes before water freezes, and is a valuable medicine as an astringent, and for internal hæmorrhage.

Bowers and Sons, of Hunslet, have two manufactories of sulphuric acid, aquafortis, and muriatic acid; and at one of them they make alum. Sulphuric is made by burning brimstone, or pyrites, and saltpetre in furnaces. The fumes from these pass through lead-pipes into large leaden chambers, containing from 7,000 to 11,000 feet, in which it combines with a stratum of water at bottom from 4 to 10 inches deep. It passes from chamber to chamber till all the fumes are absorbed by the several strata of water. The solutions of the acid in water are then boiled down in leaden vessels to a required strength, and the product is sold for bleaching, as dilute oil of vitriol. To concentrate, it is exposed in glass-retorts in sand-baths for 24 or 36 hours, and it is then sulphuric acid at full strength.

Aquafortis is made by mixing the concentrated sulphuric acid with saltpetre, and distilling them in glass vessels for 2¼ days, and the gas goes over and condenses in water in a glass receiver, the aquafortis being in strength proportioned to the water in the receiver, or single, double, and treble.

Oil of vitriol, or sulphuric acid, sold in 1829 at 2*d*. per lb., and aquafortis at 4*d*. single, and 8*d*. double, being one-third of the prices 20 years ago.

Muriatic acid is distilled from common salt and oil of vitriol, just like aquafortis.

Alum is made by dissolving clay free from iron in oil of vitriol, and boiling the solution down, and crystallizing by cooling. The alum thus made is equal to any alum known in commerce, and the crystals are often half-a-yard long, and highly beautiful. It was sold, in 1829, from 13*l*. to 14*l*. per ton, or 50 per cent. less than in 1820.

From the refuse or cinders of the pyrites, Messrs. Bowers make copperas, or sulphate of iron, for dyeing blacks and browns. —*Sir R. P.'s Tour.*

100 liquid sulphuric acid, specific gravity 1·8485, contains 81·54 dry acid. 1·5 is 61 liquid 49·74 acid. 1·3 is 40 liquid, 32·6 acid. 1·2 is 28 liquid, 22·8 acid.—If not stopped, it imbibes one-third of its weight of water in a day, and 6 times in a year. 4 to 1 of water rises from 50° to 300°, and 1 of ice to 212°, but 4 of ice to 1 of acid falls to 4° below zero.

To purify and concentrate *sulphuric acid*, distil it and throw away the first twelfth. It should be 1845.

Dilute sulphuric acid is 1 acid, 7 water, and should be 1084.

4 sulphuric acid and 1 water create such atomic excitement in the sulphur, oxygen, and hydrogen as to rise 250° in heat, and 3 acid, 1 water, rises 300°.

*Sulphuric Ether*, is 1 sulphuric acid dropt into 4 alcohol digested for 3 days. Then add 1-12th cinnamon and ginger, digest again longer, and filter for use.

Sulphuretted hydrogen, the most deadly of all the gases, whether respired or applied to the skin, is made by combining dilute sulphuric acid with black sulphuret of iron in a retort. The sulphur increases its weight from 0·0694 to 1·8 or 1·9. Air containing but the 800th kills a dog instantly. It smells like rotten eggs. It forms hydro-sulphurets when united with acids and alkalies. Boyle's fuming liquor, or hydrogenated sulphuret, was a mixture of 2 parts of muriate of ammonia, and of quick-lime, with one part of flowers of sulphur, heated to redness in a retort. The liquor in the receiver is then agitated in a bottle with its weight of flowers of sulphur. It then gives its fumes.

Sulphur itself is said to form acids called sulphides, and no less than 16. 3 of hydrogen, carbon and phosphorus, with 13 of metals, now figure in books. Realger is called sulphide of arsenic, orpiment sesqui-sulphide of arsenic, and mosaic-gold bisulphide of tin.

Sulphuret of carbon is a liquid which quietly evaporates, and produces intense coldness. It is made by distilling charcoal and pyrites. A rag wet with it, and laid on a thermometer bulb, sinks it 50° or 60°.

Sulphur and treacle, thoroughly incorporated, in the proportion of about two tea-spoonsful of sulphur to one table-spoonful of treacle; taken when necessary, in a full desert-spoonful either at night, or early in the morning, promotes a regular alvine discharge.

SUMACH, a shrub, twelve or fifteen feet high, common in the United States. It is cultivated in the European gardens for ornament. A very abundant milky juice flows from the bark, and is pulverized and employed for tanning.

*Dog-wood*, or *poison sumach*, is not uncommon in the United States. It attains the height of twelve to twenty feet, and has such poisonous qualities, that some persons are effected by touching or smelling any part of it, or even by coming within a certain distance. When the poison has been communicated, inflammation appears on the skin, in large blotches, in a day or two; soon after, small pustules rise in the inflamed parts, and fill with watery matter, attended with intolerable itching and burning, which lasts several days. Japan varnish is obtained from a species formerly considered identical with poison sumach; but now recognised as a distinct species, having the under surface of the leaves downy and velvety. This varnish oozes from the tree, on its being wounded, and grows thick and black when exposed to the air. It is so transparent, that, when laid pure and unmixed upon boxes or furniture, every vein of the wood may be clearly seen. With it the Japanese varnish over the posts of their doors and windows, their drawers, chests, boxes, cimeters, fans, tea-cups, soup-dishes, and most articles of household furniture.

SUMMER; in the northern hemisphere, the season comprehended in the months of May, June, July, August, and September; the warmest period of the year. South of the equator, the summer corresponds, in time, to our winter.

SUN-FLOWER.—The value of this plant is scarcely known. The seed forms most excellent feed for poultry, and it is only necessary to cut off the heads of the plant when ripe, tie them in bunches, and hang them in a dry situation. They are also valuable feed for sheep and pigs, and for pheasants. The leaves, when dried, form good fodder for cattle; the dry stalks burn well, and afford abundance of alkali, and, when in bloom, the flower is attractive to bees. The seeds, also, produce excellent oil for the table.

SUPERSTITION, is faith in what never existed, or in powers and effects, without mechanical or material connection, and is the bane of many lives among the lower and ignorant classes. Burns gives the best list of them, as devils, ghosts, fairies, brownies, witches, warlocks, spunkies, kelpies, elf-candles, warnings, dead-lights, wraiths, cantrips, raw-heads, bloody-bones, evil-eyes, &c. &c.; to which may be added, the superstitions of the schools and book-makers, invented in the same ages as the preceding, as attraction, repulsion, caloric, gravitation, sympathy, suction, and other such trumpery; there being no causes of material phenomena but the transfer of motion, in action and reception, or by some material agent or agents, in some degree of momentum, acting variously on different patients.

SUPER-TARTRATE OF POTASH, cream of tartar, or chrystals of tartar, is 2 acid, and 1 potash. It is diuretic and cathartic; and 1 dr. in a pint of water, with lemon-peel and sugar, is imperial. Two drs. added to a pint of boiling milk, is cream of tartar whey.

SUPPORTERS OF COMBUSTION, are, in chemical theory, such gas as produce the phenomena of flame, in connection with any excited hydrogen.

1. *Oxygen*, whose combination produces the power of the others, and, in fact, is the fundamental, if not the only supporter.

2. *Atmospheric air*, a compound of oxygen and nitrogen.

3. *Chlorine*, or oxy-muriatic acid, a compound of oxygen, sulphur, and sea-salt, being made by sea-salt and sulphuric acid, as muriatic acid, and then this, united with black oxide of manganese, forms *oxy*-muriatic acid.

4. *Iodine*, or essential salt of kelp, and of various *algæ*, combined with sulphuric acid and manganese.

5. *Bromine*, is a variety of the products of sea-salt, and is like the others, an alkali combined with oxygen and sulphuric acid.

As supporters of combustion, the three last are so peculiar in their phenomena, and so temporary, lasting only as long as their oxygen lasts, that they are so classed rather for the sake of scientific method, than as natural supporters. The quantity of oxygen in their compound confers, also, on them modified characteristics of oxygen in their combinations with acidifiable and alkaline bases. Fluorine is still more equivocal.

Their equivalent numbers are, oxygen 8, atmospheric air 64, chlorine 36, iodine 126, bromine 8, fluorine 18.

SURGEONS, COLLEGE OF, a very distinguished corporation, which meets in Lincoln's-inn-fields, London, where its astonishing museum serves as a type of the enlightened character of the body to which it belongs. Perhaps there is nothing English which receives more homage through the world than its surgery, and no patent of nobility assures higher respect in all foreign nations, than a diploma from the London college of surgeons.

SUSPENSION-BRIDGES, are bridges made of ropes, or chains, stretched from side to side of a river, or from pier to pier, and of such strength as to uphold the platforms, or ways for passengers, carriages, &c. A patent was taken out by Jordan, for such a bridge, in 1795, but they are now becoming common in the United Kingdom and United States, and they are very convenient in mountain passes, and across rapid streams. They are also cheaper than stone, or iron bridges of the usual structure. In some cases, they have been made of great strength, by lengths of iron wires. The Dryburgh is 260 feet span, the Berwick 361 feet, and the Menai 580 feet, and 100 above high-water.

The most striking circumstance in these bridges is their great economy, as compared with ordinary, or what are called *insistent* bridges.

Iron, independently of its cheapness and extensive diffusion, is singularly and admirably adapted for the construction of suspension-bridges. When it is considered, that the greater part of the weight of these bridges arises from the chains themselves, it is evident, that the best material for the purpose is that which has great tenacity with small weight; and thus we find, that iron is at the same time the most tenacious, and, excepting tin, the lightest of the common metals. A square inch of good iron requires about 28 tons to separate it, and it will not be stretched, or otherwise effected, with less than half that weight.

Where, however, economy and portability are important objects, rope-bridges will be found advantageous, and they have been, during the last few years, extensively introduced into British India. One of these bridges, 160 feet in length, is so light and portable, that it may be set up and removed in a few hours.

Messrs. Palmer and Dick have proposed *suspension-railways*, to which carriages are to be hung, and moved on rollers with great velocity. The estimated expence is £1400 per mile, but at present it is only a plausible theory.

*Suspension Piers* have been very successfully raised by Captain Brown, on shores where no solid pier could have endured the force of storms. 4 or 5 piers may thus be raised of open iron-work or timber, so as to permit the free passage of water, and a bridge suspended from these by chains, so as to make a perfect landing-place in deep water for goods and passengers. The chain, of course, takes a new bearing at each pier, and a suspended flooring makes a secure and pleasant passage. His admired pier at Brighton stood the shocks of 10 winters, but at length has suffered unexpected damage from lightning, owing to the mass of metal and the interruption of the links of the chain.

SWEET BAY, or LAURUS NOBILIS, our evergreen laurel, yields an oil from its berries, which is narcotic, and used for flatulencies and female complaints, but resembles, in its effects, diluted prussic acid.

SWIMMING, greatly strengthens the lower extremities, the abdominal muscles, the muscles of the chest, and the organs of respiration, the spine, neck, and arms. It may be easily learned wherever there is water of five feet depth. Of the many methods of teaching swimming, that introduced by General Pfuel, into the Prussian swimming-schools, is superior to any other.

The apparatus for teaching consists of a hempen girdle of a hand's breadth, of a rope from five to six fathoms in length, of a pole eight feet long, and a horizontal rail, fixed about three and a half feet above the platform on which the teacher stands, to rest the pole on.

The depth of the water, in the place chosen for swimming, should, if possible, be not less than eight feet, and the clearest and calmest water possible should be selected. The pupil wears drawers, fastened by a string above the hips, and covering above half the thighs. They must be made loose, so as to allow the free action of the legs.

The swimming-girdle, about five inches wide, is placed round the pupil's breast, so that its upper edge touches the paps, without sitting tight. The teacher takes the rope, which is fastened to a ring of the girdle, in his hand, and directs the pupil to leap into the water, keeping the legs straight and close together, and the arms close to the body; and, what is very important, to breath out through the nose, as soon as his head is above the water.

He is drawn up immediately by the rope, pulled to the ladder, and allowed to gain confidence gradually. The rope is now fastened by a noose, to the end of the pole, the end of it being kept in the hand of the teacher; the pole is rested on the horizontal rail, and the pupil stretches himself horizontally in the water, where he remains, supported by the pole. The arms are extended stiffly forward, the hands clasped; the chin touches the water; the legs are also stiffly stretched out, the heels being together, the feet turned out, the toes drawn up. This horizontal position is important, and must be executed correctly. No limb should be relaxed.

The motion of the legs is taught first: it is divided into three parts. The teacher first says, loudly and slowly, "*One;*" when the legs are slowly drawn under the body, and, at the same time, the knees are separated to the greatest possible distance; the spine is bent downwards, and the toe kept outwards. The teacher then says, briskly, "*Two;*" upon which the legs are stiffly stretched out, with a moderate degree of quickness, while the heels are separated, and the legs describe the widest possible angle, the toes being contracted and kept outwards. The teacher then says, quickly, "*Three;*" upon which the legs, with the knees held stiffly, are quickly brought together; and thus the original position is again obtained. The point at which the motions two and three join, is the most important, because it is the object to receive as large and compact a wedge of water between the legs as possible, so that, when the legs are brought together, their action upon this wedge may urge the body forward.

In ordinary easy swimming, the hands are not used to propel, but merely to assist in keeping on the surface. By degrees, therefore, two and three are counted in quick succession, and the pupil is taught to extend the legs as widely as possible. After some time, what was done under the heads two and three, is done when two is called out.

When the teacher sees that the pupil is able to propel himself considerably, which he frequently acquires the power of doing in the first lesson, and that he performs the motions already mentioned with regularity, he teaches the motion of the *hands*, which must not be allowed to sink, as they are much disposed to do, while the motion of the legs is practised. The motion of the hands consists of two parts: when the teacher says, "*One*," the hands, which were held with the palms together, are opened, laid horizontally an inch or two under the water, and the arms are extended, until they form an angle of 90°; then the elbow is bent, and the hands are brought up to the chin, having described an arch downward and upward; the lower part of the thumb touches the chin, the palms being together. When the teacher says, "*Two*," the arms are quickly stretched forward, and thus the original horizontal position is regained. The legs remain stiffly extended during the motion of the hands. If the motion of the hands is correctly performed, the legs and arms are moved together; so that, while the teacher says, "*One*," the pupil performs the first motion of the hands and legs; when he says, "*Two*," the second and third motions of the feet, and the second of the hands.

As soon as the teacher perceives that the pupil begins to support himself, he slackens the rope a little, and instantly straightens it, if the pupil is about to sink. When the pupil can swim about 10 strokes in succession, he is released from the pole, but not from the rope. When he can swim about 50 strokes, he is released from the rope too; but the teacher remains near him with a long pole, until he can swim 150 strokes in succession, so that, should he sink, the pole is immediately held out to him.

Swimming on the back is easily taught. The swimmer places his hands over his hips, the thumbs turned towards the back, and, letting himself sink perpendicularly in the water, bends his head backward, and makes the common motion with the feet, when he will swim on the back; or, after having made a stroke when swimming on his belly, he may leave one arm extended, and turn the palm of the hand upward; in which case the whole body will follow, and the swimmer thus be placed on his back. To expedite the motion in swimming on the back, the arms may be used as paddles.

Diving is one of the greatest amusements connected with swimming. 1. By a simple jump, feet foremost, the legs, arms, and head, being kept stiff. The pupil must not allow fear, or the strange sensation felt in the abdominal region, in leaping from considerable heights, to induce him to spread the arms or legs, or to bend his body. 2. The other mode is, to plunge head foremost, which is the safest mode for many persons who are heavily built about the chest and shoulders, if they have to enter the water from great heights. It must be learned by degrees. The head is drawn down upon the chest, the arms stretched forward, and, as soon as the swimmer begins to feel that he has lost his balance, he stiffens his knees, which, till then, were bent. The diver must avoid striking on his belly,—the general consequence of fear—and turning over so as to come down on his back or side—the consequence of pushing with the feet. When he has gone as deep as he wishes, the arms are to be raised, and pressed downwards.

SYKES'S HYDROMETER, is the revenue guage of the strength of spirits. It is of brass, 6·7 inches long, with a stem 3·4 inches, divided into 11 parts, a brass ball, and a loaded bulb. There are also 8 circular weights, numbered 10 to 80. The density and rarity of the fluid is indicated by the depth to which the stem sinks when the bulb is immersed, and the ratio above or below proof determined at sight. This hydrometer is severely criticised in the recent work of Mr. Gutteridge, and many faults exposed, with apparent reason.

SYMPATHY, one of the powers invented in the same age as attraction, repulsion, &c. and put forward in all the writings of *soi-disant* philosophers for nearly 200 years. It was ascribed to affections of the *mumia*, the spirit of matter, or soul of the world, which passed from dying bodies into rising generations. Hence, whatever took place in the parts of a man's body, as in his blood, &c., when taken to any distance, affected his entire system, and the treatment, &c. of the part equally affected the system; or the death of the system killed the part. Such execrable nonsense led to the invention of Digby's Sympathetic Powder, for curing wounds, stopping bleeding, &c.; and it was the same soul of matter that made bodies attract and repel one another. This execrable nonsense pervaded surgery, medicine, and philosophy, down to the age of Queen Anne; and, on the Continent, and among the vulgar, through half the 18th century, and even in such of its ramifications it fills books down to our own age.

SYPHON, or crane, is a bent tube, with one leg longer than the other, so that its orifice may be lower; if, then, the air is sucked out, the short leg being in a fluid, the fluid will continue to flow till the surface is below the orifice. Or, if the syphon is filled before it is immersed at the short end, the fluid will run out at the lower end, and will be followed as before. The syphon, for many domestic purposes, is most convenient.

SYRUPS should contain 2 parts of sugar to 1 of fluid; if it exceed, the syrup crystallizes, and if less, the syrup ferments. A bottle that holds 3 oz. of water should, by adding the sugar, hold 4 oz. of syrup. Sulphate of potash, or oxymuriate of potash, in trifling quantity, will arrest fermentation in syrups.

*Syrup of Liquorice. (For Coughs.)*—In 3 pounds of boiling-water infuse (24 hours) 2 oz. of liquorice-root, ½ an oz. of hyssop, and 1 oz. of white wall-rue; press out, and add 10 oz. of refined sugar, and of best honey.

*Syrup of Poppies.*—In 2½ gallons of water mix 14 oz. of poppy-heads, without the seeds; boil to one half, and powerfully express the liquid; of this, take a quart, and boil to a pint, strain, and add 2 lbs. of white sugar.

*Syrup of Sarsaparilla.*—In a gallon of water infuse 1 lb. of sarsaparilla-root; boil to less than half the quantity, and add 1 lb. of sugar.

*Syrup, simple*, is made by boiling a mixture of 1 lb. of sugar in half a pint of water, to consistency.

TABASHEER, is a stony concretion, formed in the joints of the bamboo cane, and used in diseases arising from obstructions. It possesses the highest refractive power on light.

TALC, or Muscovy Glass, is brought from Russia, in square lumps, and separable into plates of singular thinness. It is used to glaze ships' windows, from not breaking when great guns are fired, and also in microscopes, to confine objects.—English talc, or *asbestus*, is fibrous, and used to make wicks for lamps, and cloth which is incombustible by a moderate heat. It also absorbs oil of vitriol, and prevents its being spilled from bottles with chemical matches.

TALENT, was a multiple of the coin of the Ancients, which, in silver, was worth 342*l.* 3*s.* 9*d.*, and, in gold, 5475*l.* str.

TALIACOTIAN OPERATION, for restoring lost noses, lips, &c. called after Taliacotius, who restored it, in the 16th century; after which it fell into disuse, till revived, about 20 years ago, by Mr. Carpue, the eminent London surgeon of Great Charlotte-street. It was a practice described by Galen, and seems to have been well known to the Hindoos. Its success arises from the well-known principle of healing by the first intention; as, when the lips of a wound are united and kept together till the parts reunite. Bones reunite, in like manner, when brought together, or set, by osseous matter, supplied by the arteries.

Such is this power of adhesion, that the end of a finger, cut off by accident, has been replaced and reunited, as before. The nose, cut off, has been replaced, only with the aid of adhesive plaster. Tendons and arteries reunite in like manner. One part of an animal may be made to grow on another part, and parts of one animal on another. Grafting trees is on the same principle; and the top of a tree may be grafted into two others, and live between them, without trunk or roots. In animal wounds the reunion takes place by adhesion or adhesive inflammation.

In the case of restoring a nose, a sufficient surface of the integuments of the forehead is turned over, twisted, and then united, at the edges, with the integuments of the face, on the outline of the proper base of the nose; and the part is thereby inosculated, and kept alive by the circulation, till, by granulation by the lymph of the blood, it is filled up as a firm fleshy nose.

This is the Indian and *Carputian* method; but Taliacotius used to cut a piece from the arm, then fasten the arm over the head, and inosculate the slip, keeping the arm fixed till the adhesion was confirmed as a nose, or for 12 or 14 days. The idea of cutting a piece from another man was a witty idea of Butler. Mr. Carpue performs the operation in half an hour, and in four or five weeks the patient is free from surgical attention.

TALLOW, is animal fat, melted and separated from fibrous matter. It is firm, brittle, and has a peculiar oppressive odour. When pure, it is white and nearly insipid; but the tallow of commerce is usually yellow, and is divided, according to the degree of its purity and consistence, into candle and soap tallow. It is manufactured into candles and soap, and is extensively used in the dressing of leather, and in various processes of the arts. Latterly it has been superceded by palm-oil for soap, and cocoa-nut-oil for candles.

The best tallow is half sheep's and half ox's fat; not hog's fat, which gutters, smells, and smokes.

*The Tallow-tree* is a native of China, and belongs to the natural family *euphorbiaceæ*. At the close of the season the leaves turn bright red, and, as the capsules fall off, leaving the pure white seeds suspended to filaments. From a remote period, this tree has furnished the Chinese with the material out of which they make their candles. The capsules and seeds are crushed together, and boiled; the fatty matter is skimmed as it rises, and condenses on cooling. The candles made of this substance are very white; and red ones are manufactured with the addition of vermilion. It is now cultivated in the vicinity of Charleston and Savannah with great promise.

TANGENT, is the strait line which a body moving in a circle tends to form, if not opposed by other forces which retain it in the circle or curve. In a stone turned in a sling this force is the cohesion of the sling. In the rotating earth it is the simultaneous *greater* orbit motion, which deflects the body from the tangent to the centre. In the moon it is the simultaneous greater orbit motion of the earth and moon. In the sun and planets it is the greater simultaneous progression of the whole system through space. Two motions, at right angles, in each case, produce a diagonal orbit, and the continued deflection produces the rotation in the superior planets. In every quadrant of the orbit the fall from the tangent is equal to the distance; hence, by dividing the moon's distance by the minutes in a quadrant, we know that, in every minute, the moon falls from her tangent line about 128,000 feet, a quantity which, to suit a theory, has strangely been made 16 feet.

TANNIN, is the astringent vegetable principle which converts skins into durable leather. The most efficient are Aleppo nut-galls. These are digested, in small pieces, in water, for two or three days. Strain, and saturate with caustic ammonia; then add a solution of chloride of barium while precipitation continues. Bottle, and cork close, to settle. Decant the clear and wash the residuum. Dissolve in acetic acid, filter, and mix with acetate of lead. Wash the yellow precipitate, and decompose it with sulp. hydrogen gas, which precipitates the lead. The concentrated solution is tannin of yellow colour, and no smell, but it reddens litmus paper. It is soluble in water and alcohol, but insoluble in oils. It may also be procured from oak-bark, cinchona, catechu, &c.

Tannin may, by treatment with nitric acid, be obtained from liquorice, from resins, balsams, gum resins, or albumen.

TANNING, is founded on the fact, that the tannin principle precipitates gelatine, or animal jelly, in an insoluble state. Tannin also precipitates the sulphate of iron, lying between the hair and the skin. By strong extracts of the bark, Seguin tanned calf in 1 day, and ox-hides in 7 or 8 days. 1 lb. of catechu is equal to $2\frac{1}{3}$ galls, 3 sumach, $8\frac{1}{2}$ oak-bark, $7\frac{1}{4}$ willow-bark, and 18 elm-bark.

The skins of animals are preserved by tanning. They are immersed, for several days, or even weeks, in water with bark, mostly of oak or larch; and other astringent substances, as terra japonica, are employed, which shortens the time, but renders the substance more hard and brittle. Another method is by *tawing*. They are left to soak, for six weeks, in water, with fresh slaked lime, changed twice, rinsed, again soaked in water mixed with wheat bran, until they float, but, when beaten down, do not rise again. The bran is then scraped off, and a liquid paste is prepared, for 100 sheep's skins, 8 lbs. of alum and 3 lbs. of salt are dissolved, in warm water, and added to 20 lbs. of fine wheat flour and 96 yolks of eggs. A ladle full of this paste is put into a trough of warm water, in which 12 skins remain for some time, and are then pulled and stretched; and this is repeated twice. They are then left six days, and afterwards quickly dried.

;Slow tanning makes leather softer and stronger.

Time and labour are both materially reduced, and the quantity and weight of the leather increased, by the substitution of *water power* for manual labour, in many of the most laborious parts of the process; viz. to soften and cleanse the hide preparatory to the bark being applied to it; to grind the bark; to move pumps for transferring the decoction of the bark from one vat to another (much of which is necessary to be done daily in an extensive tannery,) and to roll the leather preparatory to its being sent to market; also the least possible quantity of lime is now used to facilitate getting off the hair. This has been found greatly to add to the weight and quality of the leather. The application of heat to bark, in *leaches*, is found to be very important, and more particularly the application of the decoction (usually termed *liquor*) to the hide, rather than the bark. In 1829, 36,360 sides of sole leather were tanned in one establishment in New York. They weighed 637,413 lbs. and were manufactured with the labour of 49 hands, and with 3200 cords of bark. This tannery has seven powerful water-wheels, adapted to its various machinery.

*Tanning by Bilberry or Whortleberry.* $3\frac{1}{2}$ lbs. of this tan dress 1 lb. of leather, while 6 lbs. are required from the oak, and tanners also gain four months.

After tanning, the currying takes place. This consists in removing all excrescences, soaking and trampling, covering with oil, and pummeling, to produce pliancy. They are then coloured, white with white-lead, black with a solution of iron, and a second of soot, vinegar, and gum.

TANSEY, is vermifuge, uterine, diuretic. It is used in colic pains and in gout. The dose, in substance, 1 dr., usually drank as tea. The seeds are substituted for worm-seed or santolina.

TAPE-WORM, one of the most stubborn worms which infest the bowels of beasts, and also of man, has its name from the broad, flat, ribbon-like appearance of each articulation and of the whole body, which is composed of these articulations. Bremser makes two species—*tænia* and *bothryocephalus*; and both kinds often reach the length of 20 or 30 feet, and usually only detached parts pass from the body, but not that which has the head; before this has passed away, the worm reproduces itself, and, moreover, what was formerly doubted, several tape-worms are often met with in one intestinal canal. The symptoms of the tape-worm are a peculiar sudden sensation of pricking in the stomach, oppression, and undulatory motions in the abdomen, anxiety, cramps, swoons, &c.

Tape-worm was, in the last century, professed to be cured with 3 drs. of the powder of the root of male fern, in water—followed, in 2 hours, by a bolus of calomel, scammony, and gamboge.

TAPIOCA, is prepared from the jatropa manhiot. The juice, which is very pungent, is expressed from the root, and the substance remaining is cassava, which swells in water, and makes a wholesome pudding.—*Paris.*

TAR, is made by the combustion of pine, and is a combination of resin and pyroligneous acid. Shook for a considerable time in water, it makes tar-water, once more esteemed than now, but still considered a very salutary article in many diseases. On good authority, it is said to cure the venereal disease, without mercury; and that its boiling vapours are unquestionably beneficial, and even curative, in pulmonary diseases. Latterly, it has been largely produced in superabundance in the distillation of coal for gas.

TARTARIC ACID, or the acid of cream of tartar and wine casks, consists of two atoms of tartaric acid and one of potash. It combines with lime and leaves the potash. Sulphuric acid again separates the lime, and produces the tartaric acid in crystals. It is much used by dyers of calicoes. Potassium is also formed from its salt. It consists of 18 carbon, 2 hydrogen, and 40 oxygen; and probably it is the hydrogen that has puzzled the question about potassium.

Tartarized kali, or *potassæ tartras*, is one acid, one potash, and soluble in four parts of water, or in alcohol. It is a mild purgative, and may be combined with senna to correct griping.

*Emetic Tartar.*—Take crocus metallorum and white tartar 4 lbs.; boil them in water, filter them, evaporate to a pellicle, and crystallize.—*Or*, Boil 8 lbs. of common antimony with 16 lbs. of sulphuric acid, in an iron pot, to dryness. Wash the gray mass till the sulphuric acid is carried off; and then mix it with an equal weight of crude tartar; boil in water and crystallize.

Tartar which forms on the teeth, and separates the gum, is phosphate of lime.

*Norris's Drops* consist of a coloured solution of tartarized antimony, in rectified spirit.

TAR VARNISH, for common outdoor work, is made by grinding tar and Spanish brown to such consistence that it may be worked with a large brush.

TAXES, are the money levied by a Government for the public expences; and, properly, are a part of the real profits of the community, for without growing private profits there can be nothing to assess. As the public grow rich the Government may be rich also; but only in that ratio. Taxes on industry, on the products of industry, on necessaries of life, and on articles of unavoidable consumption or use by all, without reference to their profits, are manifestly unjust, oppressive, and injurious. No people, too, can afford to pay to the Government more than a fourth or fifth of the aggregate of their private incomes, and all above this becomes oppressive. Nor can any generation, for temporary objects, bind posterity, since such power would be incompatible with the duration of any people, and the limitation is the only security against the waste and profligacy of an existing Government.

TEA, as a plant, strongly resembles the *camellia*. The shrub attains the height of five or six feet, and is branching and evergreen. It is a native of China and Japan, and it has been in common use in those countries from the most remote antiquity. Tea, hardly known in Europe before the middle of the seventeenth century, now employs more than 50,000 tons of shipping in transporting it from Canton. But, so vast is the home consumption, that were Europeans to abandon the commerce, the price would not be diminished.

The plant is cultivated in all parts of China, but succeeds best in south exposures, and in the neighbourhood of running water. As scarcely one in five seeds germinate, it is usual to plant several, at the depth of four or five inches. The plants require little more care than weeding. In the third year, the leaves may be gathered, and, in seven years, the plants attain the height of six feet; but are trimmed down, which produces new leaves. The leaves are plucked, one by one, with precaution; and only from four to fifteen lbs. can be collected by one person in a day. In Japan, the first gathering takes place at the end of the winter, when the leaves are young and tender, and called imperial tea. The second gathering is early in spring, when some leaves have attained their full size, and others are only expanding. The third and last gathering takes place towards the middle of summer, when the leaves are fully expanded, and are the cheapest.

The leaves are cured in houses which contain from five to ten or twenty small furnaces, about three feet high, each having at the top a large, flat, iron pan. There is also a long low table, covered with mats, on which the leaves are laid, and rolled by workmen, who sit round it. The iron pan being heated to a certain degree, by a little fire made in the furnace underneath, a few pounds of the fresh-gathered leaves are put upon the pan: the fresh and juicy leaves crack when they touch the pan; and it is a business to shift them as quickly as possible with the bare hands, till they become too hot to be endured. The workmen then take off the leaves with a kind of shovel, resembling a fan, and pours them on the mats: other operators, now, taking small quantities at a time, roll them in the palm of their hands in one direction, while a third set are fanning them, that they may cool the more speedily, and retain the curl the longer. This process is repeated two or three times, or oftener, before the tea is put into the stores, in order that all the moisture may be thoroughly dissipated, and their curl more completely preserved. On every repetition the pan is less heated, and the operation performed more cautiously.

The seeds are crushed for oil, which is in general use in China.

The effects of tea, on the human system, are those of a mild narcotic, but, of all narcotics, tea is the least pernicious. It acts, likewise, as a diuretic and a diaphoretic, and assists digestion.

Within a few years, considerable efforts have been made, by the Dutch government of Java, to produce tea in that island, with the assistance of Chinese cultivators, with some prospect of success. An experiment has also been made to propagate the tea shrub in Brazil, also with the aid of Chinese labourers.

The present consumption, in England, is above twenty-six millions lbs.; which, for nearly three millions of houses, is 9 lbs. to a house. This indicates great adulteration, few houses using so little as a lb. per month.

About a dozen kinds of tea are quoted in the Hamburgh and New York markets, and not more than six or seven are to be met with in England. Even imperial is, as yet, unknown here, though sold in the United States at 4*s*. 6*d*. and 5*s*. per lb.

In 1830, the imports into Russia amounted to 5,563,444 lbs., carried over land from Kiachta to Tomsk, and thence to Novgorod. The consumption of the United States fluctuates from about 6,000,000 to 8,000,000 lbs.

The original cost of our consumption of tea, in China, amounts to two millions sterling.

| | |
|---|---|
| 1. The cost of the importations from China into Great Britain .......... | £2,000,000 |
| 2. The East India Company charge 100 per cent. for Profits, &c. .......... | 2,000,000 |
| 3. The Government duty is equal to the original cost and the profits, both forming the sale price.. | 4,000,000 |
| | £8,000,000 |

TEA, IMITATION.—The leaves found in the possession of manufacturers of imitations, are sloe, ash, elder, and white-thorn. They are described, by the Excise, as having been, in some cases, boiled with logwood, or scalded, rolled up and dried, green bloom being given by Dutch pink or verditer!

Tea is of two kinds, black and green. The different kinds of BLACK TEA are supposed to be picked from old trees, and dried in shallow pans, over charcoal fires.—*Bohea*, (*vo he*, the name of a place,) has a black cast, and yields a deep yellow infusion.—*Congou (cong fou*, great care,) gives an infusion lighter than bohea, rather green, and seldom so agreeable in smell. It is preferred by the Chinese, and their neighbours, for their own use.—*Soutchong*, *(se ow chong*, a very little sort,) gives an infusion of a fine green, and smells agreeably.—*Pekao*, *(pe kow*, white leaf bud) infusion light and rather green, with a violet scent, and a fine savour.—*Imperial*, *(mao tcha,)* has a green cast, and the infusion is green, with a slight smell of soap.—*Campoi* is intermediate between congou and soutchong.–*Padre*, *(pou chong tcha,)* a fine soutchong, the best imported in pound papers, for presents.—*Caper*, made into balls with gum, and scented; imported only in small boxes.—Green Teas are supposed to be the young leaves of bohea-trees, dried slowly in the shade. The infusion is narcotic, in a small dose, and appeases intoxication; but a large dose causes watchfulness, nervous agitation, and even vomiting. Green teas are—*Songlo*, which has a leaden cast, and green infusion. The leaves are long, more pointed than the black teas, and the inferior sorts have yellow leaves and a smell of sprats.—*Hyson*, *(he tchune*, first crop,) has a leaden cast, with the infusion a fine green. The leaves are without spots, and open quite flat, with a strong taste, and a slight smell of roasted chesnuts.—*Tchu tcha*, *Hyson skin*, or *bloom*, the large loose leaves of the hyson, which give a faint delicate smell, and a pale green infusion. The bloom is by indigo being heated beneath it.—*Gunpowder*, a superior hyson in small round grains, of a bloom-green hue.—*Cheliun*, a scented hyson, mixed with small berries, that give it a cowslip flavour.

The leaves of tea have little or no smell, and they derive their fragrance by mixing the leaves of *Olea fragrans* and *Camellia sesanqua*, also of *Polygala thezans*, and of *Rhamnus thezans*.

China tea does not turn black by water, impregnated with sulphuretted hydrogen gas; nor give a blue tinge to spirit of hartshorn. The infusion, amber coloured, is not reddened by sulphuric acid. The leaves, separate or mixed, of speedwell, wild germander, black currants, mock orange, purple-spiked willow herb, sweet-briar, cherry-tree, hawthorn, bramble, sloe, are substituted for tea by dealers. Foreigners use a variety of plants, instead of Chinese tea, and *Zenopomathea Sinensis* is cultivated in France as a substitute. *Japanese camellia* leaves are frequently, by the Chinese, mixed with those of tea.

Russian tea, is leaves of saxifrage, winter green, white virgin's bower, bird cherry, drop worts, common elm, male fern, and dog-rose.

TEA, BOWLES'S HERB, is made of equal parts of wood betony, wood sage, and ground pine, and is useful in gout, head-ache, and nervous disorders.

TEAK, *(tectona grandis,)* is one of the largest trees known, and interesting, from the properties of the wood. It is considered superior to all others for ship-building, and is extensively used in the East in houses and temples. It is now planted, with a view to timber, in Bengal. The leaves furnish a purple dye, employed on cottons and silks.

TEASEL.—The teasel throws up its heads in July and August; these are cut from the plant, by hand, with a peculiarly-formed knife, and then fastened to poles for drying. When dry, they are picked and sorted into bundles.

The use of heads of teasel is to draw out the ends of the wool from the manufactured cloth, so as to bring a regular pile or nap upon the surface, free from twistings and knottings, and to comb off the coarse and loose parts of the wool. The head of the true teasel is composed of incorporated flowers, each separated by a long, rigid, chaffy substance, the terminating point of which is furnished with a fine hook. Several of these heads are fixed in a frame; and with this the surface of the cloth is brushed, until all the ends are drawn out, the loose parts combed off, and the cloth ceases to yield impediments to the free passage of the wheel or frame of teasels. Should the hook of the chaff, when in use, become fixed in a knot, or find sufficient resistance, it breaks, without injuring or contending with the cloth; and care is taken, by successive applications, to draw the impediment out. The dressing of a piece of cloth consumes from 1500 to 2000 heads. They are used repeatedly in the different stages of the process; but a piece of fine cloth generally breaks this number before it is finished. There is a consumption answering to the proposed fineness—pieces of the best kinds requiring 150 or 200 runnings up.

TEETH, the small bones fixed in the *alveoli* of the upper and under jaw. These are the hardest and whitest of our bones, and, at full maturity, we usually find 32 in both jaws. Each tooth may be divided into its body, or that part which appears above the gums, and its fang, or root, which is fixed into the socket. Every tooth is composed of its cortex, or enamel, and its internal bony substances. The *enamel*, when broken, appears fibrous, or striated, and all the *striæ* are directed from the circumference to the centre of the tooth. The *bony* part is much harder than bones, in general. Each tooth has an inner cavity, supplied with blood-vessels and nerves, which pass through a small hole in the root. When this hole closes, the tooth is insensible.

The teeth are divided into incisors, canine, and molars, or grinders. The incisors are the four teeth in the fore part of each jaw. The canine, or eye-teeth, are the longest of all the teeth, deriving their name from their resemblance to a dog's tusk. There is one on each side of the incisors. The molars, or grinders, of which there are 10 in each jaw, grind the food. The canine and incisors have one fang; but the three last grinders in the under jaw have two fangs, and the same teeth in the upper jaw, three fangs. The danger to which children are exposed, during the time of dentition, arises from the pressure of the teeth on the gum, so as to irritate it, till the tooth protrudes, and is such, that we may, with propriety, assist nature by cutting the gum.

Sometimes, a third set of teeth appears, about the age of 60 or 70.

Teeth are subject to a variety of accidents. Teeth are rendered carious by causes not satisfactorily explained. Disease usually begins on that side of the tooth which is not exposed to pressure, and advances, till an opening is made into the cavity: as soon as the cavity is exposed, the tooth becomes liable to considerable pain, from the air coming into contact with the nerve.

To preserve the teeth, we should guard against too hot or too cold drinks; biting of very hard substances, as in cracking nuts. Acids, of all sorts, particularly the stronger ones, injure the enamel. People who eat much meat, or have a bad digestion, or smoke tobacco, have a deposit of earthy particles around the teeth, which forms tartar. The gums, in consequence, gradually separate from the teeth. To avoid these effects, the teeth should be daily cleaned with tepid water and a hard brush, with fine charcoal or sulphur. Tartar should be removed by the dentist. Every one should have his teeth examined at intervals, to detect incipient decay.

Artificial teeth are often inserted, to remedy, as far as possible, the loss of the natural ones. Porcelain teeth have an advantage over other kinds. In age the *alveoli* fill up, and the teeth fall out.

*Tooth-ache.*—Pure nitric acid, or strong aquafortis, applied in a drop or two to a carious tooth, relieves the tooth-ache without pain, but it must be applied with care.—*Or*, Put a piece of lime, of about the size of a walnut, into a quart bottle, and with this rinse the mouth two or three times a-day, and clean the teeth, *using this water every morning*. It should be just strong enough to taste of the lime.

*Tooth-Powder.*—Mix 4 oz. of iris-root, 2 oz. of sepia, 1 oz. of cream of tartar, 16 drops of lake, and of oil of cloves. *Or*, 1 oz. of catechu, 4 drs. each of Peruvian-bark, cream of tartar, cassia, and bole armoniac, and 2 drs. each of myrrh and gum-dragon. *Or*, 2 oz. each of chalk, magnesia, iris-root, and rose-pink, 6 drs. of sub-carbonate of soda, and 2 drops of oil of rhodium. *Or*, *(Ruspini's,)* 2 oz. of cream of tartar, 1 oz. of alum, 8 oz. of sepia, 1 oz. iris-root, 2 oz. of chalk, and 6 drops of oil of rhodium.

TELESCOPE, is a contrivance for producing an image of an object with crossing rays, so that another glass, being *so* placed as that its focus may be where the image is formed, the crossing rays are by it rendered parallel, and the image is thus seen by the eye. The magnifying-power then is as the angles of the two glasses with the image; that is, as the focal length of one to that of the other. Thus, if the object-glass is 5 ft., and the eye-glass 2 inc., the power is as 60 to 2, or 30 times. The focus is the burning-point, when held opposite the sun, or where it forms a picture of any *distant* objects on a wall.

As a lens, or concave mirror, forms a picture entirely on the principle on which a common multiplying-glass acts, so, owing to varied inclinations, the figure cannot be exactly true, and (without this principle being understood,) many contrivances have been adopted to produce a true image. Hence, the great variety of telescopes. Light, too, in its undulations through glass, is variously refracted, so that images are coloured. To prevent this last fault, achromatic object-glasses have been contrived, made of two or three glasses, of different refrangibility.

We have also concave metallic mirrors, to form images which bear shorter eye-glasses, chiefly used in astronomy, though achromatic telescopes are now more common.

Telescopes appear to have been known to the British Druids, but the principle was lost till revived in Holland, at the epoch of the Spanish armada.

In 1609, Galilei constructed one by fitting a convex and a concave lens in a short tube, the lenses being so placed that the distance between them was equal to the difference of their focal distances. This is still the simplest form, if not the very best.

The common telescope has three convex eye-glasses, for the purpose of presenting the object in an erect position, and increasing the field of vision.

The bending of the speculum of a reflecting telescope 1000th of an inch, destroys its figure; hence, the weight of Herschel's 40-foot speculum soon rendered it useless, and his discoveries were made with 5-feet achromatics.

*Harris's Double-image Telescope*, is an instrument with a double or shifting object-glass, which enlarges or diminishes the field of view; and this difference is measured by a fixed micrometer. When the field and distinct vision coincide, a scale on the tubes indicates the angle of the object, and its distance.

Schroeter says, he saw, by his 20-feet reflector, a shooting meteor, which he considered to be four millions of miles distant. He also alleges that he saw clouds in the moon, and conjectured that there is a town towards the north of the spot *murius*. Dr. Gruithuisen says, that *mare imbrium* in the moon bears marks of high fertility in his telescope.

Sir James South has a 20-feet achromatic, esteemed the best in Europe, yet we never heard that he could discern these wonders in the moon, or even see the comet, which, in November last, another astronomer alleges he only saw, though 500 telescopes were for 6 weeks in constant search for it.

Any person may make a telescope by procuring a convex-glass of from two feet to ten-feet focus, fitting it in a stiff tube, and then adapting to it a concave or convex eye-glass; or three convex, to erect the object.

Spectacle-glasses act on the principle of converging the rays, so as to assist the diminishing converging power of aged eyes. But, in the case of short-sighted persons, whose eyes are already too convex, concave glasses are used, so as to render the parallel rays from objects divergent. They appear to have been known to the Greeks, though not generally made till about 1400.

As the eye obtains distinct vision by lessening the number of rays, as in the case of a pin-hole made in a card, so the Esquimaux, by a very singular refinement, have made spectacles of thin pieces of wood, with a narrow slit for distinct vision.

TELFAIRIA PEDATA; or *Feuillœa Pedata*, remarkable for the size of its fruit, which constitutes an enormous berry or pepo, from one and a half to three feet in length, and often eight inches across. It is oblong, always green, having from ten to twelve deep furrows. There are five cells, each cell filled with a dense fleshy pulp, in which seeds are imbedded in a longitudinal series. Each seed is the size of a very large kidney-bean, much compressed, and firmly enclosed in a beautiful, yellowish-brown, but tough and almost coriaceous reticulated mass of vessels.

It is a climbing-plant, brought to the Mauritius from Pemba, near Zanzibar. The fruit is three feet long, and eight or ten inches in diameter, full of seeds as large as chesnuts, (264 in one fruit,) which are as excellent as almonds, and have a very agreeable flavour; and, when pressed, they yield abundance of oil, equal to that of the finest olives. It is a perennial plant, and grows at the margins of forests, enveloping the trees with its branches; while its trunk is frequently seen with a circumference of eighteen inches.

The seeds planted in Mauritius have produced stems which are thirty feet high. Some plants flowered at Bury Hill, in 1826; and one of them flourished to such a degree, that it would have filled a large stove, had not the pruning-knife been constantly employed. A plant, so easy of cultivation, must soon become common in climates that are at all favourable to its growth, and will greatly add to our various means of increasing the product of oil, and superseding fisheries.—*Curtis's B. Mag.*

TELLURIUM, is a metal of chemistry.

TEMPERATURE, is the varied degree of sensible heat, as measured by the thermometer. The variation of heat, resulting from difference of latitude, is as follows:

| *Latitude.* | *M. Temp.* |
|---|---|
| 86° | 36° |
| 60 | 40 |
| 49 | 54 |
| 42 | 61 |
| 30 | 73 |
| 20 | 79 |
| Equator | 81 |

The variation arises from two causes, the greater or less perpendicularity of the sun's rays, and the length of time from sunrise to sunset. On the other hand, two causes of winter conspire, the rays of the sun fall more obliquely, as we increase the latitude, and the days become shorter at the cold season. Tropical regions exhibit a variation of only a few degrees, but high latitudes undergo changes amounting to 140°. Heat and cold continue to increase long after their causes have passed their maximum. Thus, the greatest cold is about the end of January, and the greatest heat about the end of July.

The sun is the chief source of heat; but, as heat is atomic motion, so the motions of the earth, and the varied reactions of its parts, create much heat. Below 80 or 100 feet, the constant temperature, with few exceptions, is found to be the mean of that at the surface in all parts of the earth.

The diurnal variations of heat, so considerable at the surface, is not to be perceived at the depth of a few feet. At the depth of 30 or 40 feet, the annual fluctuation takes place slowly. There is a small annual variation; and the greatest heat is ordinarily about the end of October, and that of greatest cold about the end of April. But, at the depth of 80 or 100 feet, the most sensible thermometer hardly exhibits any change throughout the year. From this cause, it may be, that tilling the soil máy ameliorate climate, and extensive boring might do more.

On the other hand, if we ascend above the earth's surface, we approach a region of uniform temperature, but much below the former. The tops of high mountains are covered with perpetual snow, even in tropical climates. A still greater degree of cold is found to prevail at the same height. The height of this cold region varies in different latitudes, and at different seasons. It increases as we approach the equator, and diminishes as we go towards the poles. It is higher, at any given place, in summer than in winter. It is, moreover, higher when the surface of the ground below is elevated like the table-land of Mexico, so as to afford reflections, and if the *whole* earth were three miles higher, the reflections would maintain the present temperature of the surface.

The mean temperature of the equator being 29° centesimal, and the co-sine equal radius, Mayer considers temperature in different latitudes to be as the square of the co-sine. Therefore, as the square of radius is to 29°, so is the square of the co-sine of latitude to its mean temperature in centesimal degrees. Then, to reduce centesimal to Fahr., multiply by 1·8, and add 32.

In coal-mines, the temperature at the surface and bottom is as under:

| | *Deep.* | *Sur.* | *Bot.* |
|---|---|---|---|
| Jarrow | 182 | 49½° | 64° |
| Killingworth | 900 | 48 | 70 |
| Percy Main | 900 | 42 | 70 |
| Teem, Durham | 444 | 56 | 68 |
| Whitehaven | 600 | 55 | 66 |

A degree of latitude, up or down, is equal to a degree of Fahrenheit, and as 270 feet of elevation is equal, also, to a degree of Fahrenheit; both are data to assist in determining the temperature of any country.

TERRA JAPONICA.—*See* Acacia.

TESTS.—Dried red-cabbage leaves and petals of violets, kept corked in a bottle, may, at any time, be made good tests *for acids and alkalies*, by pouring hot-water on a few of them.

*To prepare Turmeric Paper as a Test for Alkalies.*—Bruise, or coarsely grind one ounce of turmeric, and boil it in a pint of water for half an hour; strain it through a cloth, and then draw through it slips of unsized paper, which will become fine yellow, and which alkalies will render brown.

*To make Litmus-Paper as a Test for Acids.*—Triturate an ounce of litmus with hot-water in a mortar, then evaporate it to half a pint, over a lamp. Cover it to cool, and pour away the clear liquid, and add hot-water to the residue, and evaporate; mix both, and pass slips of unsized white paper through it, till both sides have acquired a blue colour, which acids will change to red.

On the contrary, if the paper is reddened by acids, an alkali will restore the original blue.

The test of the presence of *Tannin* is a solution of isinglass.

The test of the presence of *Gallic Acid* is sulphate of iron.

*For Nitric Acid.*—Pour a solution of protomuriate of iron upon the surface of an amalgam of zinc, and then place a crystal of nitre upon the latter in the fluid; a dark band immediately forms around the crystals, sometimes extending over the whole surface of the mercury. All the nitrates, as well as nitric acid, act in this manner; so that a very sensible test of the presence of nitric acid is thus afforded.

*A fluid ounce of nitric acid* ought to decompose one ounce, by weight, of limestone.

Hydrate of potash has so loose an affinity of acid and alkali, that it becomes a delicate test and means of affording either acid or alkali.

THERMOMETER, is an instrument which consists merely of a glass bulb, with a thread, or bead of mercury in a tube, and it shifts up and down as the bulb is affected and swelled by heat, or contracted by cold.

*The following are the corresponding Scales of Celsius or the Centigrade Scale of Reaumur's Scale, and of Fahrenheit, for every 5 degrees of Celsius' and of every 4 degrees of Reaumur's.*

| Cent. | Reau. | Fahr. | Cent. | Reau. | Fahr. | Cent. | Reau. | Fahr. |
|---|---|---|---|---|---|---|---|---|
| 100 | 80 | 212 | 50 | 40 | 122 | 0 | 0 | 32 |
| 95 | 76 | 203 | 45 | 36 | 113 | — 5 | — 4 | 23 |
| 90 | 72 | 194 | 40 | 32 | 104 | —10 | — 8 | 14 |
| 85 | 68 | 185 | 35 | 28 | 95 | —15 | —12 | 5 |
| 80 | 64 | 176 | 30 | 24 | 86 | —20 | —16 | — 4 |
| 75 | 60 | 167 | 25 | 20 | 77 | —25 | —20 | —13 |
| 70 | 56 | 158 | 20 | 16 | 68 | —30 | —24 | —22 |
| 65 | 52 | 149 | 15 | 12 | 59 | —35 | —28 | —31 |
| 60 | 48 | 140 | 10 | 8 | 50 | —40 | —32 | —40 |
| 55 | 44 | 131 | 5 | 4 | 41 | | | |

The *differential thermometer* consists of two legs connected, with a fluid working between them as either is made hotter than the other. It has a scale, but is not very accurate.

Thermometers are often slow in exhibiting the heat of new situations, and time should always be allowed according to circumstances, for the progression of the atomic motion into or out of the mercury in the bulb.

The degrees of Celsius, or the centigrade scale, which are not quoted, may be found by adding or subtracting for every degree 1·8 degree to, or from the degree of Fahrenheit, and those of Reaumur, by adding or subtracting 2·25 degrees to or from Fahrenheit.

THIEVES' VINEGAR, is a solution of camphor and essential oils in vinegar, and is used against contagion.

THRESHING-MACHINES often clear 20 quarters of wheat, or 30 of rye in a day. Meikle invented the drum with fixed beaters, for separating the grain from the straw. These machines increase the produce 10 or 20 per cent. independently of many advantages of expedition. But, in the meantime, threshers ought to be otherwise provided for by the great saving to the farmer and the public. It is said, that these machines, on the 3 quarters grown on 8 millions of acres in Great Britain, save a full 20th or $2\frac{1}{2}$ millions, besides saving of labour of $1\frac{1}{4}$ million. Winnowing machines are often annexed.—*See* STEAM THRESHING MACHINE.

TIDES, are effects on the mobile waters of the ocean, of the action and reaction of the earth and moon, on each other, through their common fulcrum of mutual motion, which point performs the true orbit round the sun. The tides are as the angle of the line which the fulcrum makes with the orbit. Then, as the two sides of the rotating earth necessarily balance, if a tide is raised on one side, a tide must also be created on the opposite side, by the necessary balance of both sides.

The motion of water, in tides, has been proposed as a moving power under certain circumstances, in rivers.

TILTING-HAMMER, is a large and heavy hammer, put in motion by a water-wheel, or steam-engine. Cogs being brought to bear on the tail of the hammer, its depression causes the head to be elevated, which, when liberated, falls with considerable force by its own weight. Tilt-mills, for tilting steel, is the process by which blistered steel is rendered ductile.—*See* STEEL.

TIMBER.—Trees of different species vary greatly in the durability of their wood. The decay of timber is sometimes superficial, and sometimes internal, distinguished by the name of the *dry-rot*. The disease begins in the interior substance of the wood, particularly of that which has not been well seasoned, and spreads outwardly, causing the whole mass to swell, crack, and exhale a musty odour. Its destructive effects in ships have given rise to numerous publications, and it is now stated, that experiments of Farady prove that corrosive sublimate is a cure.

At whatever period timber is felled, it requires to be thoroughly seasoned before it is fit for the purposes of carpentry. The object of seasoning is partly to evaporate as much of the sap as possible, and thus to prevent its influence in causing decomposition, and partly to reduce the dimensions of the wood, so that it may be used without inconvenience from its further shrinking. Timber seasons best when placed in dry situations, where the air has a free circulation round it, and gradual drying is considered a better preservative than sudden exposure to warmth, even of the sun; for warmth, abruptly applied, causes cracks and flaws, from the sudden and unequal expansion produced in different parts. When wood is to be kept in a dry situation, as in the interior of houses, no other preparation is necessary than that of thorough seasoning.

For extracting the sap, the process of *water-seasoning* is recommended, and it consists in immersing the green timber in clear water for about two weeks, after which it is seasoned in the usual manner. A great part of the sap, together with the soluble and fermentable matter, is said to be dissolved or removed by this process, and running water is more effectual than stagnant.

The *charring* of timber, by scorching or burning its outside, is commonly supposed to increase its durability; and, probably, the pyroligneous acid, which is generated when wood is burnt, may exert a preservative influence. The exclusion of moisture, by covering the surface with a coating of paint, varnish, tar, &c., is a well known preservative of wood which is exposed to the weather. A coating of tar or turpentine, externally applied to seasoned timber, answers the same purpose as paint, if it is renewed with sufficient frequency. Wood impregnated with drying-oils, such as linseed-oil, becomes harder, and more capable of resisting moisture, and it is frequently the custom to bore a perpendicular hole in the top of a mast, and fill it with oil, which, gradually absorbed, penetrates to a great distance.

The preservative quality of common salt is seen in the hay of salt-marshes, which is frequently housed before it is dry, and yet remains unchanged for indefinite time. In the salt-mines of Poland and Hungary, the galleries are supported by wooden pillars, which last unimpaired for ages. Wooden piles, driven into the mud of salt-flats and marshes, last for an unlimited time. The practice of docking timber, by immersing it, for some time, in sea-water, after it has been seasoned, is generally admitted to promote its durability, and there are some experiments which appear to show, that, after the dry-rot has commenced, immersion in salt-water effectually checks its progress, and preserves the remainder of the timber.

TIN is found as *tin-stone*, hard, heavy, and brilliant. It is a peroxide with some iron. It is broken, mixed with coal and lime-stone, and fused for some hours. The furnace is then tapped. It is afterwards gently melted at 442°, skimmed, and cast into blocks. As an alloy, &c. it is a most useful metal, and when hammered has a sp. gr. of 7·285.

The perchloride, is 6 of tin, 1 of mercury, and 33 of corrosive sublimate. In the air it fumes and smokes, and with one of water 3 parts become a solid. In contact with bromine it forms a solid. The persulphuret or mosaic gold, 12 tin, 7 sulphur, 3 mercury, and 3 sal-ammonia, produces the gold by sublimation in light scales. It is insoluble in water, alcohol, or nitric, or muriatic acids.

Its oxides are used in enamelling, and to polish the metals; and its solution in nitro-muriatic acid is an important mordant in the art of dyeing, rendering several colours, particularly scarlet, more brilliant and permanent.

There are but two *tin ores; tin ore*, and *tin pyrites*. The first of these occurs crystallized, and in a great variety of forms. The *wood-tin* of the Cornish mines is a mere variety of tin ore. *Tin pyrites*, the other ore of tin, occurs massive, with a granular composition. Before the blow-pipe, sulphur is driven off, and the mineral melts into a blackish scoria. It is soluble in nitro-muriatic acid, during which the sulphur is precipitated. It consists of tin 34, copper 36, iron 2, sulphur 25.

*To reduce Oxyde of Tin.*—Pulverize 8 lbs. and mix with 1 lb. of powdered charcoal, and 4 lbs. of borax. Heat it in a crucible with some charcoal over it, and the pure tin will be at the bottom.

TINFOIL, is a compound of tin and lead, and very useful.

TINCTURES, consist of solutions of vegetable and medical properties in alcohol, or proof spirit. 36 of Beaumé's hydrometer is best adapted to resinous products; 32 to extractives; and 22 to gummy, which corresponds in sp. gr. with 0·837, 0·856, and 0·915.

*Tincture of Myrrh, (simple).*—In 8 oz. of alcohol infuse a ½ oz of myrrh, and 2 drs. of (subcarbonate of potash) salt of tartar. *(Compound)* In one pint of alcohol infuse 1 oz. each of myrrh and of aloes. Of much utility, to prevent suppuration of green wounds.

*Tincture of Squills.*—In 2 lbs. of alcohol mix 4 oz. of fresh squills. The dose 10 to 30 drops.

*Tincture of Opium* is a spirituous solution; but laudanum, or wine of opium, should never be confounded with it.

TITANIUM, is a metal of chemistry.

TOAST AND WATER.—Take a slice of fine and stale loaf-bread, cut very thin, (as thin as toast is ever cut;) and let it be carefully toasted on both sides, until it be *completely browned all over*, but nowise blackened or burned in any way. Put this into a common deep stone or china jug, and pour over it, from the tea-kettle, as much clean boiling-water as you wish to make into drink. Much depends on the water being in a boiling state. Cover the jug with a saucer or plate, and let the drink cool.

TOBACCO, so extensively cultivated in Virginia, and so capable of cultivation in Britain, is an annual plant, 3 or 4 feet high, with large leaves of dull pale green. To increase the size and number of these, the plants are topped. They are cut in fine weather, in August or September, and then hung in the shade to dry. The leaves are separated, and packed, or cut and manufactured as tobacco or snuff.

As tobacco is cultivated for the leaves, it is an object to render these as large and as numerous as possible; and new, fresh, and fertile soil is preferred. It is very sensible to frost. The plants are raised on beds, early in spring, and when they have acquired four leaves, they are planted in the fields, in well-prepared earth, about three feet distant every way. Every morning and evening the plants require to be looked over, in order to remove a worm which sometimes invades the bud. When four or five inches high, they are moulded up. As soon as they have eight or nine leaves, and are ready to put forth a stalk, the top is nipped off, in order to make the leaves larger and thicker. After this, the buds, which sprout from the axils of the leaves, are all plucked; and not a day is suffered to pass without examining the leaves, to remove a large caterpillar.

When they are fit for cutting, which is known by the brittleness of the leaves, they are cut, with a knife, close to the ground; and, after lying some time, are carried to the drying-shed, where the plants are hung up by pairs, upon lines, having a space between, that they may not touch one another. In this state they remain, to sweat and dry. When perfectly dry, the leaves are stripped from the stalks, and made into small bundles, tied with one of the leaves. These bundles are laid in heaps, and covered with blankets. Care is taken not to overheat them; for which reason, the heaps are laid open to the air from time to time, and spread abroad. This operation is repeated till no more heat is perceived in the heaps, and the tobacco is then stowed in casks for exportation.

Tobacco consists of mucilage, albumen, gluten, extractive, a bitter principle, an essential oil, nitrate of potash, muriate of potash, and nicotin. The essential oil and nicotin are highly potent, the one on the brain, and the other on the heart. The green leaves, like dock-leaves, relieve the stings of nettles.

TOADS. The common toad has been an object of horror, and it has been accused of being poisonous, but certainly is guilty of no other crime than that of being very ugly.

TOLU-LOZENGES, consist of sugar 8 oz., cream of tartar 1 oz., starch 2 drs., tincture of toluferæ balsami 1 dr., with some mucilage of gum tragacanth.

TOMATA, or LOVE-APPLE, *(solanum lycopersicum,)* is cultivated in Sicily and Calabria, and enters largely into Italian cookery.

TONICS, are substances that give tone to the stomach, and vigour to the body. They consist of the bitter or extractive principle generally, as gentian, camomile, hops, wormwood, quassia, water, trefoil, &c. taken in aqueous solutions, two or three times a day.

TONNAGE. By the tonnage of a ship is meant the weight of the cargo she is intended to carry, from her light to her load-water-line, when equipped for sea. The following rules, for computing the tonnage of a ship, are commonly adopted and made use of between the contractor and builder, at a certain rate, per ton, for the building. The contractor finds a saving in less breadth and great depth: on the contrary, great breadth and less depth is more advantageous to the builder.

The general rule for measuring the tonnage of ships is to let fall a perpendicular from the fore-side of the stem, at the height of the upper deck, or middle deck, in three-deck ships, and another perpendicular from the aft-side of the main-post, at the height of the wing-transom; but, in merchant-ships, the foremost-perpendicular is let fall from the fore-side of the stem, at the height of the wing-transom. From the length between these perpendiculars deduct three-fifths of the extreme breadth, (that is, the thickness of the bottom plank on each side added to the moulded-breadth,) and, likewise, as many $2\frac{1}{2}$ inches as the wing-transom is above the upper-edge of the keel, and the remainder is reckoned the length of the keel. Then multiply this length of the keel by the extreme breadth, and that product by half the extreme breadth; and divide the product by 94. The quotient will be the burthen in tons, or the builder's tonnage.

Thus, in the length from the fore-side of the stem, at the height of the upper-deck, to the aft-side of the main-post, at the height of the upper side of the wing-transom, is 182 ft. $9\frac{1}{4}$ inc.; from which deducted three-fifths of the extreme breadth, 29 ft. $2\frac{3}{5}$ inc., added to the height of the wing-transom 26 ft. 10 inc., which produces for every $2\frac{1}{2}$ inc., 5 ft. $6\frac{3}{5}$ inc.

Then the length of the keel, for tonnage, is 148 ft. Multiply this by the extreme breadth, 48 ft. 8 inc.; and again by half. Divide by 94, and the burthen in tons is $1864\frac{1}{3}$ tons.

Such is the tonnage, from which, deducting the weight of the ship, &c. &c. her real power of burthen is about two-thirds, or 1240 tons.

TONQUIN REMEDY.—Mix 6 grs. of camphor, 16 grs. of musk, and 1 scr. of valerian-root powder.

TOPAZ; one of the most interesting gems. Its crystals are short prisms, terminated, at one or both extremities, by a great number of facets, the primary form being a right rhombic prism of 124° 22′; specific gravity, 3·49.

Topaz consists, according to Berzelius, of

| | Topaz. | Physalite. | Pycnite. |
|---|---|---|---|
| Alumine | 57·45 | 57·74 | 51·00 |
| Silex | 34·24 | 34·36 | 38·43 |
| Fluoric acid | 7·75 | 7·77 | 8·84 |

With borax, it melts slowly into a transparent glass, and its powder colours the tincture of violets green. Topaz enters into the composition of several granitic rocks. It occurs, also, in irregular beds, either with quartz and mica. It is met with in the alluvial deposits of rivers, with other gems.

The topaz is now too abundant in nature to command extravagant prices. It is afforded plentifully in Brazil, and in the tin-mines of Saxony, Bohemia, and Cornwall; at Cairngorm in Aberdeenshire, and in the mountains of Altai and the Urals.

TRACING-PAPER, is made by washing tissue-paper with a mixture of equal parts of spirits of turpentine and mastic-varnish, the transparency being as the varnish.

Artizans transfer drawings to wood by laying paper, covered with soft red chalk, or pipe-clay, on the wood, and then following the lines on tracing-paper with a hard point, so as to impress the same, through the red paper on the wood. This nearly resembles the similar practice in engraving.

TRADE, is the interchange of commodities, and, in an enlarged sense, of labour and commodities. It divides itself into *Home-trade* and *Foreign*.

*Home-trade* comprises producers, or agriculturalists; artizans and manufacturers; and dealers, or distributors in shopkeepers, and carriers by land and water.

*Foreign-trade* comprises exporters and importers, or merchants, and the shipping interest.

The producers in Great Britain appear to occupy about 187,000 such farms as employ labourers. Then, taking the land of all qualities at 37,000,000 acres, this is about 200 acres to a farm, or about 66 of good land, 68 of second-rate, and 66 of mere sheep-pasture. Their gross produce is about 4*l*. 4*s*. per acre, or 160 millions, (taking wheat at its present average of 52*s*.,) serving as the fundamental basis of our national resources.

This production employs, or subsists, 1¼ millions of our male population, above the age of 21 years, as occupiers, cottagers, and labourers.

Then there are mineral products, of coals, iron, lime, copper, tin, lead, stone, slates, &c. worth about 20 millions more, and employing about 50,000 males above 21 years of age, besides boys.

To these native products we may add the *imports* against our machine manufactures, amounting to a portion of the 50 millions of imports, or about 35 millions.

So that our actual income, in products of industry, is about 160 + 20 + 35, or 215 millions.

This, in labour on native products, taken at 33 per cent. on the 160 millions, is 53⅓ millions, and in minerals at 30 per cent. is other 6⅔, or 60 millions together.

To which may be added, other 50 millions for productions of various arts and tasteful ingenuity.

And the produce of our machinery, applied to foreign raw materials, estimated at 62 millions.

In all, 172 millions, from productive labour, which, added to the products 215, renders the aggregate annual wealth, for distribution and consumption, about 387 millions.

But, if to this be added freights and carriage 13 millions, the total is about 400 millions per annum.

But it is with a nation as with an individual, it consumes as it produces. Its wealth is merely its power of comfortable subsistence. It may therefore be estimated, that the population of 17 millions spend, in food and lodging, 1*s*. per day, or 4*s*. 9*d*. per family, or 850,000*l*. which, in 365 days, is 317,550,000*l*. If to this we add 2*l*. per family for clothing, we get other 70 millions of expenditure, making, for subsistence, lodging, and clothing, 387,550,000*l*. or within 12 millions of the bounds of production and national labour.

Then, from these are to be transferred 60 millions to annuitants, for state taxes and assessments, and other 40 millions, for rentals of land, to another class of proprietors and mortgagees, making one-fourth of income, and abstracting about a tenth from the pittance of 4*s*. 9*d*. per family, and 20*l*. for clothing. Such is the sum and substance—the beginning and the end—of the state of the British people.

One circumstance, peculiar to Great Britain, is the mechanical agency of fire, steam, and air, in manufacturing. This is expressed, in one of the above items, at 62 millions, as labour on foreign raw materials. In fact, 600,000 men, women, and children, produce as much cotton fabrics, by the aid of machinery, as 6 millions; and in wool, flax, silk, and metals, an equal number produce an equal amount of labour, *i. e.* machinery, in effect, produces an amount equal to 11 millions of men, women, and children; and, it may be observed, that this mechanical power neither eats nor drinks, and, of course, pays no taxes.

As an exemplification of trading employments, we are enabled, by the unwearied intelligence of Mr. Marshall, to place before our readers a correct analysis of the population of Great Britain, and of the subdivisions of industry in its principal trades. For details, we must, in justice, refer to his separate publications.

It appears, that, in Great Britain, in 1831, there were 3,414,175 families, containing 16,262,301 individuals, male and female; or 4·73 in a family.

And the employments which engage about 10,000 individuals in each are, in the order of numbers, as under:

| | |
|---|---|
| Shoemakers | 133,248 |
| Carpenters | 103,247 |
| Tailors | 74,054 |
| Publicans | 61,231 |
| Blacksmiths | 58,142 |
| Masons | 49,155 |
| General Shopkeepers | 38,150 |
| Butchers | 35,218 |
| Bricklayers | 29,593 |
| Bakers | 27,942 |
| Grocers | 22,147 |
| Cabinet-makers | 21,774 |
| Wheelwrights | 19,950 |
| Millers | 19,796 |
| Sawyers | 19,181 |
| Carriers | 18,859 |
| House Painters | 15,653 |
| Linen-drapers | 13,601 |
| Coopers | 13,246 |
| Plumbers and Glaziers | 11,999 |

| | |
|---|---|
| Hucksters ............. | 10,881 |
| Hatters and Hosiers .. | 10,858 |
| Coach-owners ........ | 10,514 |
| Brickmakers .......... | 9,864 |
| Plasterers ............ | 9,683 |
| Whitesmiths .......... | 9,543 |

Mr. Marshall's list descends to those employments of which there are not above half a dozen.

Literature affords subordinate numbers; thus, we have printers 8342, paper-makers 4164, bookbinders 3599, booksellers 3327, stationers (mostly booksellers) 2797, copper-plate printers (including calico) 2663, printsellers 593.

Of shoemakers, there appear to be 1 to every 26 families; carpenters, 1 to every 33 families; tailors, 1 to every 46 families; publicans, 1 to every 56 families; blacksmiths, 1 to every 60 families; and so on, down to those of 10,000 men, or 1 to 341 families nearly.

The cottagers, independantly of farmers (above), are 168,815 families; and the distinct labourers in agriculture, males above 21, are stated at 887,167.

The manufacturers in the great staples are 404317 males above 21.

The merchants, professions, bankers, proprietors, money-jobbers, and annuitants, are about 450,000 males above 21, or one-eighth of the population.

The female-servants are 670,491.

The male-servants are 78,669, and those under 20 are 74,555.

The total in Great Britain, of males above 20 years of age, was 3,944,511, out of a gross male population of 8,163,023.

*Foreign Trade* has peculiar features. If a merchant ship goods worth in his country 100*l.* in gold, it may be worth, at the foreign port, but 50*l.* of gold; but as commodities bear nearly the same relative price as to gold in both countries, so he re-ships at the price of the foreign port, and sells at home at the home price, which was the first price of his cargo. But, if he seek to bring back gold and silver, then the result of his transaction depends on their relative value in his goods in both countries, for gold and silver being the currency of nations and their standard, it bears nearly an equal market-price every where, and is not subject to the variable quantities of climates and seasons, to the caprices of markets, and to the ignorance of relative value which exists in regard to most other articles.

A merchant may perchance go among savages and obtain 500 lbs. weight of gold for 100*l.* worth of fancy articles, or he may for once exchange for 10 times the value in silk, but such is not the routine of regular trade among nations which derive perennial advantages from mutual dealings. The owners of gold and silk soon ascertain the relative value, and leave the merchant only current advantages, except when he has it in his power to obtain any article of which another people happen to be ignorant of the relative value in another country.

When a merchant does not make a direct exchange in goods for goods, or does not sell his cargo to one, and repurchase a return cargo on the spot, the interchanges of value are effected by middle men, called negociants or exchange-brokers. These being known, he who exports and has to draw a bill for the amount, puts it into the hands of the broker, or the broker knows where he can apply for it, and then he who imports and desires to realize his sales in bills, receivable at home, applies to such negociant for any bills on his country, and a bargain being struck obtains them for the produce of his imports.

Of course, the bargain depends on the facilities of the negociant, for, if the imports exceed the exports between the two places, then bills will be scarce and bear a premium; but if the imports are less than the exports, then the bills of exporters will be abundant, and they will give a premium to those who, having imported, desire to buy them.

But it may happen that although the exports and imports between two places do not balance, and the account may be all one way as to one of them, yet, as those who buy must sell, so a negociant has bills on other places from exporters to those places, and he sometimes gives these to an importer, or draws himself or equalizes the different bills so as to balance accounts between different places as to their respective excesses of exports and imports. An exchange-broker is therefore an important personage in the adjustment of mercantile transactions *between nations.*

If the imports to any place from another place constantly exceed the exports, and the negociant is obliged himself to draw bills, instead of giving other bills, for money paid him by importers, then he must, from time to time, send gold or silver to meet his bills, or remit bills on other places, where the course of trade is different. In general, little gold passes in equalizing such transactions, but if a country is a general exporter, gold must occasionally be remitted to meet bills drawn. At the same time as the exchange-brokers are generally Jews, whose fraternity extends over the world, so bills are first interchanged of one country on another, as far as practicable, and direct remittances of bullion are avoided, as the last resort.

It is evident, in following these details, that no country can continue to trade, unless, on the whole of its trade, there is an equivalent. Payments cannot continue to be made, if there are not equivalent receipts. The exchange-brokers would soon stop the credit of such a nation. In truth, a country resembles a manufacturer, whose ledger exhibits balances against him from all of whom he buys raw materials, and articles of domestic consumption; but, are in his favour, from all to whom he sells his commodity. The general balance constitutes his profit, and if bills were drawn on him for his imports, (into his factory,) and, by him on others for his sales, (exports,) these would correspond with the bills of foreign merchants, in their transactions with one another. If he pay a high rent, (taxes,) and consume largely, (luxury,) he must work his people or machinery hard, to secure suitable balance; but, if his trade decline, or competition reduce his profits, and his rent (taxes,) and consumption, (luxury,) continue, his welfare is endangered, and he must soon be a bankrupt.

The limits of prosperity in foreign trade, and the badness of system pursued, are proved by the results. In every great branch of our foreign trade general ruin has fallen on the parties, and we may especially quote the universal insolvency of the East India trade, and the West India trade and their interests. It is, in truth, the same with every other branch, South American, &c. &c. but the interests are less consolidated and classed, and hence the ruin is less noticed. In fine, foreign trade is only beneficial when in few hands, and when demand precedes exportations, and consumption opens the market for re-supply. The power of purchase, the policy of rulers, and the habits and prejudices of people, set a limit not to be passed; and, not to feel and to be convinced of this, is worse than the folly even of chivalry. The Asiatic and African caravans have made their periodical tours for many thousand years, but the caravan system would destroy itself, if the number were so multiplied as to cause supply to precede demand and consumption. Nor are the adventures of merchants, their exports or imports, their losses or gains, any affair of governments, or any unequivocal test of public prosperity; consequently, their exhibition by finance ministers is a proof either of their ignorance or knavery. If there are profits, so much the better for the *individual* merchants; it raises them in their parish; and if losses, they sink the master-speculator into a servant; but these are not state-affairs. It is true that great exports of *slights* may employ more machinery, but machinery does not "constitue a state," and we have no mundane patent for our machines. On this subject, great mistakes are made by superficial vassal reasoners and rhodomontade writers, fatal to the happiness and true interests, not only of the British people, but of the human race.

Of course, the advantages of all foreign trade, suppose subsistence-wages to the labouring producers, and fair profits on the capital and skill of those who employ them. There can be no other object and end in foreign trade than this, and, if it is not so, then we are labouring for foreigners, and not for ourselves, and great exports are merely great mischiefs, and accumulating means of national impoverishment.—Yet such for some years is believed to have been the state of the foreign trade of England, the operative manufacturers have got a bare subsistence, on the coarsest and cheapest food, and their employers are living on their capital, and working their costly machinery at a loss. They keep on in hope, because, to suspend their operations, would be to lose every thing at one stroke, and each flatters himself, that he may be able to hold on longer than his competing neighbours.

Undue foreign trade in nations is so subject to competition, and to political circumstances, that it soon finds its limit, and then retrogrades. In two or three centuries, it has always worn itself out, in every place where it has acquired ascendancy. The increase of transactions multiplies credits, and reduces the value of currency, so that great nominal wealth misleads governments, and ambition, increase of dominion, and wars, are results of fancied superiority. Over-trading and over-manufacturing have limits in consumption and prices, governed by the means of other nations, to repay in advantageous commodities.

At present, Great Britain employs nearly 20,000 ships in exporting a real value of about 34 millions sterling, in manufactured goods and produce; and, in importing, about 46 millions of raw materials for manufacture, and tropical produce for consumption. The power of machinery has created so great an excess over power of purchase, that three times more, in bulk and labour, were exported in 1832, for 34 millions, than from 1800 to 1808, for 38 or 39 millions.

**TRANSPARENT BLINDS**, are painted with transparent colours on stretched cambric, prepared by a coat of hot solution of isinglass or parchment-glue. The transparent colours are lake, prussian blue, umber, sienna, and vandyke-brown; and, other colours are made *semi*-transparent when ground with the mastic varnish used in blind-painting.

Transparent blinds are also elegantly

made by perforating, or punching with a machine, thin sheets of metal, with such numerous holes that vision is not obstructed by the intermediate divisions. They are now in general use. The same machine has also been applied to make lanthorns, cullenders, strainers, dredgers, &c. all elegant improvements.

TRANSPLANTATION, is an operation whose success depends on the plant being torpid, and on its spongioles being uninjured. If it be growing, or evergreen, and the spongioles are uninjured, the removal will produce no injury except the temporary suspension of the action of the spongioles. Old trees in which the roots are much injured form new ones so slowly, that they are liable to be exhausted of sap by the absorption of numerous young buds before new spongioles can be formed. The amputation of their upper extremities is, therefore, the most probable prevention of death; but in most cases injury of the roots is fatal.

TRANSPORTATION, the forcible sending any one out of his native country, or usual domicile, owing to crimes or offences against the laws. In this way North America and Australasia have been peopled. Of late, a most extraordinary and flagitious proposition has been made to transport the children of the poor, merely because poor, and to bind them in the colonies to masters, after the manner of convicts, for terms of years. This seems to be the *ne plus ultra* of the assumptions of wealth; at least, our criminal law contemplates only one step beyond. It is pretended that consent of the ignorant children and afflicted parents is first to be obtained; but, alas! what really free choice have such persons? So daring and hypocritical a proposition, as a remedy against the flagrant abuses and monopolies of society, will be an ever-memorable feature of the sophistical dogmas of political economy, in an age otherwise enlightened and benevolent.

TREE-PLANTING.—Tens of thousands of English acres, scarcely capable of maintaining rabbits, might be planted with advantage. *Resinous* trees on the *highest grounds*, *hard-wooded* trees on the *best ground*, and *soft-wooded* trees on the *boggy-ground*, afford good remuneration. As the trees grow, the soil increases, and is fit for a crop of oaks, &c. by the time that the pines or firs are thinned for timber-trees. If an acre of such land is bought for 10*l.*, and planted for 5*l.*, by contract, with larch-fir, Scotch-pine, birch, and mountain-ash, in equal proportions; in the course of 15 years, such trees will be from 15 to 30 feet high; and, if they have been *well-pruned*, they will be still higher and more valuable. But, to prune a tree *well*, is to prune it while it is young, at 6 ft. high, and 2 ft. up the stem. The trees should be gone over in this manner every two years. Scotch pine is thinned out first for rails, &c.; the best of the larch are left for timber trees; the birch, mountain-ash, &c. are cut periodically for crate-rods, &c. &c.; and oaks, &c. may then be introduced into all vacant places.

*To cure Wounds in Elm-trees.*—Each wound is to have a hole bored in it with an auger, and then a tube, penetrating an inch or less, is to be fixed in each. Healthy trees which are thus pierced give no fluid, but those which are unhealthy yield fluid, which increases in abundance with the serenity of the sky and exposure to the south. Stormy and windy weather interrupts the effect.—In from 24 to 48 hours the running stops, and the place dries up.

*Hide-bound Trees.*—The greatest benefit arises from cutting or slitting the rind of fruit-trees when hide-bound; but the practice is of little use, unless carefully done down to the surface of the ground, or rather below, and likewise a little along the horizontal branches. Trees carefully done in this way blossom several days before those not cut at all.

*In transplanting shrubs*, dig a narrow trench round the plant, leaving its roots in the middle, in an isolated ball of earth; fill the trench with plaster of Paris, which will become hard in a few minutes, and form a case to the ball and plant, which may then be lifted and removed any-where.

TRUFFLE, a genus of mushrooms, remarkable for growing entirely underground, a few inches from the surface. They attain the diameter of two or three inches, and in certain districts are astonishingly abundant. They abound most in light and dry soils, especially in oak and chestnut forests. Hogs are extremely fond of them, and lead to their discovery by rooting in the ground. The truffle is usually about as large as an egg; is entirely destitute of roots; the skin blackish or gray, studded with small pyramidal warts; the flesh white, gray, or blackish, varied with black or brown veins. They are prepared for the table in various manners, but should be eaten with moderation.

TRUMPET, SPEAKING, is any tube of considerable length, as from six feet to twelve, and is used to make the voice heard to a great distance, by restricting its direction.

TRUMPETER, a South American bird, about as large as a domestic fowl. It is easily tamed, and shows as much attachment and fidelity to its master as a dog. It obeys his voice, caresses and follows him, and recognises him after a long absence. It drives away all strange animals, and fears neither cat nor dog. Those which live in the streets will often attach themselves to a stranger, and follow him wherever he goes. In short, these birds are superior to all others in intelligence and social disposition.

Flocks of sheep are reported to be often confided to their charge, and that they constantly bring them home, and it is certain that the care of poultry may be intrusted to them.—*Encyclopædia Americana.*

TRUSS, a bandage or apparatus employed in ruptures, to keep up the reduced parts, and hinder a fresh protrusion. A truss ought so to compress the neck of the hernial sac, and the ring, or external opening of the hernia, that a protrusion of any of the contents of the abdomen may be completely prevented. It should make an equal pressure on the parts without causing inconvenience to the patient, and be so secured as not easily to slip out of its right position. Every truss consists of a pad, for compressing the aperture through which the hernia protrudes, and of another piece, which surrounds the abdomen; to these are sometimes added a thigh-strap and a scapulary, which passes over the shoulder.

TRUTH, the object of all enquiry, is disguised in society by so many interests and crafts, and by such deep-rooted prejudices and powerful influences, that it is discovered with great labour, and seldom governs human affairs. The object of all public councils, of Parliament, and of the public press, is to determine truth, as the guide and test of policy and conduct; but, passion and sophistry generally prevail, and truth is generally ascertained only by fatal after-experience. Hence, the History of Nations, in spite of plausible exertions to determine truth, is a narrative of follies, mistakes, and crimes, and then of experiments and expedients to avert their evil consequences, followed by too late, shame and repentance.

The best chance of arriving at a true decision is by unanimity; but, as that is impracticable, owing to passion, pride, and interest, decisions should be by such a majority as allows for these. Perhaps, one-third of every assembly are under their influence; hence, all open decisions should be made by 2 to 1, or in the British Parliament for example, by 440 to 220, and, in that proportion, 330 to 328, affords a chance to truth, only as the numbers.

The law, very properly, demands unanimity in the verdict of a jury; since, it ought to be a truth, or as much so as precaution can make it. If seven decided against five, the decision would be only a probability as seven to five, or seven times right and five times wrong, while punishments and consequences are certain. This principle, however, is often lost sight of, and majorities, in many cases, inflict great wrongs, as in arbitration, and many current practices. Pride, passion, and self-interest, are almost wholly excluded in the vote by ballot: hence, its general introduction would be the most valuable of all social improvements.

TULIP-TREE *(lyriodendron tulipifera)*; one of the most remarkable productions of North America. It is second in size only to the button-wood; but, the fine form of the trunk, the beauty and singularity of the foliage and flowers, entitle it to rank among the most magnificent vegetables. It delights only in deep, loamy, and extremely fertile soils. In some parts of the Western States it constitutes, alone, pretty extensive tracts. Stocks have been measured more than twenty feet in circumference, whose height was estimated at from 120 to 140 feet: and, sometimes, the trunk is perfectly straight, and uniform in diameter, for more than forty feet. The heart, or perfect wood, is yellow, approaching to a lemon-colour, and the sap white. It is much heavier than the poplars, and the grain is equally fine, and more compact: it is easily wrought, polishes well, and is strong and stiff. Wherever it abounds, it serves for the interior work of houses, and sometimes for the exterior covering, in situations where it is difficult to procure pine-boards. The panels of doors and wainscots, and the mouldings of chimney-pieces, are made of this wood. The Indians prefer this tree for their canoes, which are made of a single trunk, very light and strong, and sometimes carry 20 persons.

TUNGSTEN is a metal of chemistry.

TUNNEL.—The tunnel under the Thames, at Rotherhithe, at a place where it is 1000 feet wide, had been advanced in a double line for 500 feet, when the water rushed through the crown, and drowning 6 of the workmen, filled up the tunnels. The aperture was stopt from above, and the water pumped out; but the capital being expended, it remained an abortive curiosity, till a late Act enabled the Treasury to lend the necessary funds to effect its completion. It is lighted by gas, and may be entered by visitors with security. The heighth of the arch is about 16 feet, and the width of each line such as to admit a coach or waggon, with a foot-pavement at the side.

Some years since, Mr. Vallence, of

Brighton, proposed an enclosed air-tight tunnel, for rapid conveyance, by rarefying the air at one end, so as to produce a force of propulsion from the other end. He calculated that goods and passengers might in this way be transported from London to Brighton, 52 miles, in half an hour. As a mere theory, we forbear to enlarge, though Mr. V. made some expensive experiments to verify it, and had many converts.

TURF may be advantageously translated, in pieces 3 inches square, and planted 6 inches asunder. In two seasons 1 acre spreads over 9 acres, and makes sound pasture.

TURMERIC, the root of the *curcuma longa*. It is brought from the East Indies, and is very rich in a yellow colour. Common salt and sal-ammoniac are the mordants best adapted to fix it. The root must be reduced to powder, to be fit for use. It is sometimes employed to give the yellow made with weld a gold cast, and an orange tinge to scarlet; but the shade which the turmeric imparts soon disappears. It constitutes a principal ingredient in curry-powder, and in this form is used in great quantities, both in India and Europe.

TURNING, is a very ingenious and useful art, by which a great variety of articles are manufactured, by cutting or fashioning them while they revolve upon an axis. Every solid substance in nature may be submitted to this process; and, accordingly, we have articles turned in the metals, in wood, in pottery, in stone, in ivory, &c. Among the great varieties of *lathes*, it is indispensably required, for circular turning, that the work should be supported by two steady centres, or by parts equivalent to two centres, at a distance from each other in the axis of rotation, and that the tool should be supported by a steady bar, or a piece called the *rest*.

Clock and watch-makers use a very cheap, simple, and portable lathe, called a *turn-bench*, consisting of a straight bar of iron, about five inches long, with two cross bars or heads, about two inches long, one fixed at the end of the long bar, and the other capable of being shifted by means of a socket and screw. In each of these heads is a centre-pin, terminating in a point at one end, and in a central hole at the other, like the centre-pin in the poppet-head of any other lathe; the use of which is to afford point centres when the points are turned towards each other, or hole-centres when the contrary is the case; and, lastly, there is a small rest, with its support, slidable and adjustable along the bar, as in another lathe. These instruments will, therefore, support any piece of four or five inches long, and three inches diameter, between the centres; and the method of producing the rotation is by passing the catgut-string of a bow once or twice round the work, and drawing the bow backwards and forwards with one hand, while the other is employed in applying the tool. The turn-bench itself is held steady in a vice fixed to a bench or stand.

The common lathe of the turners in wood, called the *pole-lathe*, is the same thing as the watchmaker's turn-bench, but upon a large scale, and a little varied. Instead of the horizontal bar, it has two long stout bars of wood, called *shears*, forming what is called the *bed* of the lathe, and its two poppet-heads are upright blocks of wood, mortised in between the shears, above which they rise and carry the centre-screws, and between which they are moveable, and may be wedged firmly at any required distance from each other. The work itself is either put between the centres, or upon a wooden mandrel, and is made to revolve by a string or band, proceeding from a long spinning pole at the ceiling or roof of the shop, round the work, and thence to a treadle or foot-board, which acts by alternate pressure from the foot, while the workman applies the cutting tool with his hands.

The velocity of rotation may be extremely swift in wood, slower in brass and bell-metal, still slower in cast-iron, and slowest of all in forged iron or steel. Steel and iron require to be kept wet.

If the poppet-heads, supporting the mandrel, be made regularly to move from side to side, during the rotation, or the rest be made to approach to, and recede from, the work, any number of times in a turn, the cuts will not be circular, but undulating, indented, or waved in any curve that may be required. The motion is commonly regulated by certain round plates of brass fixed on the mandrel, called *roves*, which have their edges waved, and are called *roses*. The largest columns, the most ponderous artillery, and the minutest pivots of watch-work, with all wheel-work, rotatory machines, vessels, &c. are worked by this machine.

*Turning of Earthenware and Porcelain* is requisite, to give unto circular vessels their correct figure, and proper size and thickness. The lathe has similar arrangement to that for turning wooden-vessels, &c.; with this addition, the treddle has a cross-piece, for convenience of a treader, giving motion more readily to the wheel and spindle, and of properly regulating that motion, while the turner is steadily engaged in his operations. Outside of the head-stock of the lathe, on the screw, is fixed a *chuck*, of the size proper for the inner surface of the edge of the vessel, to fit easily. The turner stands looking towards the headstock, (not exactly linear with his lathe, as does the wood-turner), and is separated from the wheel by a wainscot partition, so as to prevent any of the clay-turnings falling on the machinery. The treader stands at the end of the spindle, on a raised position, so that the foot requires the treading, to give force to the treddle. At the side of the treader is a board, on which are the vessels from the thrower, one of which is constantly handed over to the turner as he needs it.

The turner places the vessel on the chuck, and, with his finger, presses its edge firm, or fixed to the clay-ring previously formed on it, the treader gives motion to the spindle, and the turner, by his tools of very thin steel, varying in breadth for the several vessels, carefully abstracts all the surplus clay left by the thrower, and likewise adds all the elegance the pattern suggests; and, after this is finished, the treader expertly gives to the spindle a retrograde motion, during which the turner applies the flat surface of his tool to the vessel, and thereby gives the whole a solidity not previously existing, and also a glossy smoothness, preventive of any inequalities the prior operation might have left. It will be readily conjectured, that this manipulation affords much opportunity for exercising taste and genius, and requires considerable practice, to prevent the articles being fractured and destroyed.

In manufactories, where the lathes have motion from a steam-engine, the lathes are so constructed as to receive increased velocity for those parts of the operation which require it. There is a general spur, or driving-shaft, along the room, nigh the wall, and a drum fixed on it, over each lathe, over which a belt passes. The lathe has a small shaft fixed parallel to its spindle, with one fixed and two loose pulleys; from the drum, the belt passes round the fixed pulley, which will give motion to either of those loose that may be geared with it. One of these gives the direct motion to the spindle, and the other, to the cossed belt, gives the retrograde.

Some articles, after being taken off the turner's lathe, are only required to be gradually dried, to be ready for being baked in the biscuit-oven; others require to be *ornamented*, *figured*, or *hurdled*, and are placed where they will not dry quickly.

Many articles of a circular figure, and some *hollow-ware*, of even oval, are formed and finished on a mould, placed on the head of a vertical spindle, moved by a winch (not dissimilar to a lapidary's wheel), and a larger of clay (butted, as described under *pressing*), is laid on the mould, and, by swage and sponge, as the spindle revolves, has the full thickness and shape, at the same operation, completed. This is much used to fabricate saucers and plates.

TURNER'S CERATE, is a well-stirred mixture, of equal parts of calamine and yellow wax, and double of olive-oil, over the fire. Mixed with nitrous oxide of mercury, it is a stimulant to indolent ulcers; and, with subacetate of lead, is a cure for burns and scalds.

TURNIPS, are a very important crop for the winter-food of sheep and cattle, but they are often injured by a small fly, or beetle, for which, as yet, no certain remedy has been discovered. The produce is 30 tons per acre, when they succeed. Bone-dust, or lime-manure, is the last specific named as a preservative, but the cases are not sufficiently numerous; $1\frac{1}{2}$ bushels are mixed with a load of common dung.

TURPENTINE, is prepared from the *Pinus Pistachia*, and consists of resin and an essential oil. Canada turpentine, or balsam, approximates balm of Gilead in qualities. Venice turpentine is used as a diuretic. Riga balsam is made from the *Pinus Cembra*, and Hungarian balsam from the *Pinus Pumilio*. The essential oil dissolves in 6 parts of sulphuric ether. It is a powerful diuretic, and the basis of several public nostrums, and highly useful in burns and scalds.

All kinds of turpentine are obtained by exudation, and hardening of the juice flowing from incisions into the pine-trees. To obtain the oil of turpentine, the juice is distilled in an apparatus like the common still; water is placed with the turpentine, and the residuum and product exceed the original weight: 250 lbs. of good turpentine produce 60 lbs. of the oil. 16 oz. of Venice turpentine, being distilled with water, yielded 4 oz. 3 drs. of oil of turpentine; and the same quantity, distilled without water, yielded, with the heat of a water-bath, 2 oz. only. When turpentine is distilled, or boiled with water till it becomes solid, it appears yellowish; when the process is farther continued, it acquires a reddish-brown colour. The oil of turpentine, called also *spirit of turpentine*, cannot, without singular difficulty, be dissolved in alcohol, though turpentine itself is easily soluble in that spirit.

*Turpentine Enima*, for obstinate costiveness, is made of $\frac{1}{2}$ an oz. of turpentine, and the white of an egg, beat up and diluted with a pint of warm water.

ULMIC ACID, is made from the black exudation from elms, &c.

ULTRA-MARINE, is the best blue, and prepared by heating *lapis lazuli* in a retort, and mixing sulphuric acid, followed by lixiviation. The other blues are bice, Prussian-blue, and indigo.

Guimet, of Toulouse, has succeeded in forming it artificially. Prepare hydrate of silica and hydrate of alumine; the former is obtained by fusing well-powdered quartz with four times its weight of carbonate of potash, dissolving the fused mass in water, and precipitating by muriatic acid; hydrate of alumine is procured by precipitating a solution of alum with ammonia.—These two earths are to be carefully washed with distilled water. After this, the quantity of dry earth remaining is to be ascertained, by heating to redness a certain quantity of the moist precipitates. Dissolve afterwards, with the assistance of heat, as much of this hydrate of silica as a solution of caustic soda is capable of taking up, and determine the quantity dissolved. Take, then, for 72 parts of the latter (anhydrous silica) a quantity of hydrate of alumine, which contains 70 of anhydrous alumine; it is to be added to the solution of silica, and the mixture is to be evaporated, with constant stirring, until a moist powder only remains. This combination of silica, alumine, and soda, is the base of the ultra-marine, which is to be coloured by sulphuret of sodium, in the following manner:—Put into a Hessian crucible, provided with a good cover, a mixture of two parts of sulphur, and one part of anhydrous carbonate of soda; it is to be gradually heated, until, at a moderate red-heat, the mass is well-fused; this mixture is then to be projected, in very small quantities at a time, into the middle of the fused mass; as soon as the effervescence, occasioned by the vapour of water, ceases, a fresh portion is to be thrown in. Having kept the crucible moderately red-hot for an hour, it is to be taken from the fire and suffered to cool. It now contains ultra-marine, mixed with sulphuret in excess, which is to be separated by water. If there be sulphur in excess, it is to be expelled by a moderate heat.

UNIONS.—Metals unite with one another; earths with earths; oils with each other; carbon with iron; sulphur with phosphorus yielding a liquid; earth with some metallic oxides and fixed alkalies, in any proportion sulphur; with metals, oxides and earths; phosphorus with carbon, metals, and earths; acids with alkalies, earths, and metallic oxides, &c. in definite proportions.

UNIVERSAL JOINT, is the union of two strait rods, connected by semicircles, and moving round each other. It was one of the many inventions of that universal genius Robert Hooke, who first published the Theory of Gravitation.

UNIVERSITIES, are designed to be the nurseries of learning, but from their constitution and statutes, it is only the learning recognized and established in remote ages. They admit no improvement of doctrine or practice till it has been forced upon them by the unanimity of the world. The professors are chosen by a council of seniors, educated, practised, and bigotted, in favour of the opinions taught to them in a preceding age, and conformity is the bounden, or implied duty of any elected professor. He is to teach and to defend; and his merit is measured by the zeal of his advocacy, and the pertinacity of his sophistry. Such are the obstructions which the most obvious discovery must undergo, before it is admitted into the orthodox body of university learning, and taught to the rising generation.

No doubt this evil might be obviated by some fit arrangements, and the general value of universities renders such arrangements desirable; but the influence must proceed from without, and that influence be specially elected and guarded. Perhaps, after all, this vice of university-learning is the limit of their usefulness, which cannot be passed; though, till it is passed, the real utility of endowed universities will always be questioned.

Close civic corporations generate a contemptible and corrupt magistracy; and all close election, like breeding in and in, deteriorates the race. But it is a ten-fold calamity when so mistaken a system is allowed to lower the intellectual character of the guardians of public education, and thereby poison the stream of knowledge at its source.

It is a circumstance almost incredible, that, owing to the perpetuation of monkish institutions in most universities, arising from the system of self-election, which generates a continuity of prejudices in favour of ancient statutes, the subjects taught are, for the most part, such as have no application to the business and interests of future life; but, on the contrary, the honours and degrees are conferred for acquirements which, in general, have an inverse ratio to their probable or possible utility. The time which might be employed with so much advantage in acquiring all the practical sciences to which we are indebted to modern experiment and research, are, by an obliquity of reason, devoted to the acquirement of as much of certain obsolete languages as was familiar to the mechanics of the countries of which those languages were vernacular tongues; while it is notorious that not an idea exists in those languages which is not transferred into English; and, at the same time, the principles contained in their writings refer, for the most part, to states of society and manners utterly different from our own.

If society advances in arts of civilization, it is in spite of the obstructions of universities; but how much more rapid and effectual those advances might have been if the means and capabilities of universities had concurred, and if the time wasted in learning equivalent words for the same idea, in two or three *obsolete* languages, had been employed in enlarging the stock of ideas, and in the study of the same number of *living and useful* languages.

URANIUM, is a metal of chemistry.

URIC ACID, is found in urine, and is the base of calculi.

The *uric acid* is a constant ingredient in urine; it is sometimes in the state of a white impalpable powder, sometimes in small four-sided prisms, having considerable lustre.

URINE, is a fluid which, by accumulation within the body, would prove fatal. It is secreted by the kidneys, whose sole office it appears to be to separate from the blood the superfluous matters that are not required for nutrition. The substances, which, in particular, pass off in this way, are nitrogen and various saline and earthy compounds. Perspiration carries off more or less of the fluid which would else have passed off by urine: so that the profusion of the former is attended with the diminution of the latter. The specific gravity is 1·03. It gives a red tint to litmus paper, which indicates the presence of a free acid, or of a supersalt. The numerous researches made concerning urine have given the following as its component parts; 1. water; 2. urea; 3. phosphoric acid; 4, 5, 6, 7. phosphates of lime, magnesia, soda and ammonia; 8, 9, 10, 11. lithic, rosacic, benzoic and carbonic acid; 12. carbonate of lime; 13, 14. muriates of soda and ammonia; 15. gelatin; 16. albumen; 17. resin; 18. sulphur.

Healthy urine is composed of water 933, urea 30·10, sulphate of potash 3·71, sulphate of soda 3·16, phosphate of soda 2·94, muriate of soda 4·45, phosphate of ammonia 1·65, muriate of ammonia 1·50, free acetic acid, with lactate of ammonia, animal matter soluble in alcohol, and urea, 17·14, earthy phosphates with a trace of fluate of lime 1·0, uric acid 1, mucus 0·32, silex 0·3 in 1000.

But this fluid is subject to a great variety of morbid conditions. Of those substances which, though naturally wanting, are sometimes contained in the urine, the most remarkable is *sugar*, which is secreted by the kidneys, in diabetes. Diabetic urine has a sweet taste, and yields a sirup by evaporation.

The sugar, when properly purified, appears identical, both in properties and composition, with vegetable sugar.

The acidifying process which is constantly going forward in the kidneys, as evinced by the formation of sulphuric, phosphoric, and uric acids, sometimes proceeds to a morbid extent, in consequence of which, two acids, the *oxalic* and nitric, are generated; neither of which exists in healthy urine; and the former, by uniting with *lime*, gives rise to the worst kinds of urinary concretions.

The French operation of breaking the stone has diminished the ancient danger of that terrific disease, and is now practised in the London Hospitals.

VALERIAN, *(sylvestris,)* has a root very sudorific, diuretic, antiseptic, vermifuge, and anti-epileptic, if given in powder, in doses of 1 scr. to 1 dr. This plant, and its oil, allures cats and rats.

VALVES, are close traps, in pumps and machinery, which open or shut one way. For the passage of water, the clack-valve, made of leather and wood, is generally used, working on a side-axle, or a central-axle, or pyramidical. A steam-valve is a flat metal plate, bevelled at the edges and guided by a pin, as an axis. In air-pumps they are of oiled silk, with a grating. But, for every purpose, caoutchouc is the best material. In the great London works, valves are as much as 30 inches in diameter; and the great column of water makes them act with astonishing force.

VANADIUM, is a metal of chemistry.

VARNISHES, much used in the arts, are as under:—

*Copal Varnish. Transparent.* Saturate 4 oz. of alcohol with camphor, and

*Common Varnish.*—In 1 quart of alcohol mix 8 oz. of gum sandarac, and 6 oz. of Venice turpentine.

*Transparent Varnish.*—In 1 quart of alcohol mix 2 oz. gum mastick, 4 oz. of Venice turpentine, and 8 oz. of gum juniper. For wood.

*White Varnish.*—In 1 quart of alcohol mix 1 lb. of juniper gum and 6 oz. of Strasburgh turpentine. For wood, linen, and paper.

*White Hard Varnish.*-Pulverize 3 oz. of cullet, (flint glass, or use 3 oz. of potter's dried flint;) mix with 4 oz. of mastich, and 2 oz. of juniper gum and of Venice turpentine, which put into 1 quart of alcohol. For cards, sheaths, &c.

*White Polishing Varnish.*—In 1 quart of alcohol mix 8 oz. of juniper gum, 2 oz. of mastich in tears, 1 oz. of gum elemir, and 4 oz. of Strasburgh turpentine. For metal, with pumice-powder. In this dissolve 1 oz. of copal, in fine powder, and filter. In 1 pint of alcohol dissolve 1 oz. of gum elemi: mix the two liquids.—*Or, (for Pictures.)* In 1 pint of alcohol dissolve ½ oz. of camphor, which mix with 4 oz. of coarse powder of copal, and, by heat, form the mixture, till whatever bubbles arise may easily be counted. Cool, decant, and add more alcohol, to be similarly treated, till there is no residuum.—*Or, (for Metals, Chairs, &c.)*—Mix well 4 oz. of powder of glass, (or potter's flint,) 2½ oz. of Strasburgh turpentine, 3 oz. of gum mastich, 6 oz. of gum sandarac, and 3 oz. of copal, melted and dropped into water. Add the whole to 1 quart of alcohol.

*Copal Varnish, (Sheldrake's).*—Take of copal, broken into small pieces, 2 oz., spirit of ammonia 2 oz., or camphor 2 drs., rectified oil of turpentine 1 pint. Stop the vessel, with a cork cut in grooves, to admit a portion of the heated vapours to escape; bring it to boil over a brisk fire, so that the bubbles may be counted as they rise; keep the mixture at the same heat; for, if the least irregularity, or overheating, takes place, it is useless to proceed. When the solution is complete, let the vessel be quite cool before it is opened. The vessel is of tin, or other metal, strong, shaped like a wine-bottle with a long neck, and capable of holding two quarts.

Copal varnish may be dissolved on pictures, &c. by a boiling solution of an eighth of ammonia, in oil of turpentine, but it requires very skilful management.

*Japanner's Copal Varnish.*—In a glass mattrass melt and evaporate 4 lbs. of copal, and pour in 1 pint of boiling hot linseed-oil; remove the matrass, and, while hot, add equal weight of oil of turpentine.

*Gold Varnish, for Leather.*—In 2 pints of oil of turpentine mix 1½ scrs. of gamboge and turmeric each, 4 oz. each of seed lac and gum sandarac, ½ oz. of dragon's-blood, 2 oz. of turpentine, and 4 oz. of pounded glass, (or potter's flint)—use the clear.

*Varnish for Coloured Drawings.*—Mix 1 oz. of Canada balsam and 2 oz. of oil of turpentine. Size first with isinglass, and dry before using the varnish.

*Indian Varnish.*—In 1 quart of alcohol, by a gentle heat, dissolve 5 oz. of shell lac and of seed lac. Strain for use.

*Hard Spirit Varnish.*—In 1 quart of alcohol dissolve 3 oz. of seed lac and of yellow rosin.

*Black Varnish.*—In 1 quart of alcohol dissolve 4 oz. of gum sandarac, and 2 oz. of yellow rosin; then add 1 oz. of lamp-black.—*Or,* Alcohol and black sealing-wax, to colour it.

*To make Caoutchouc Varnish.*—Melt the caoutchouc in a close vessel, at nearly the temperature to melt lead, and stir it. Oil of turpentine should be carefully added to it, which will render it easily applicable, and leaves the substance, when dry, a firm varnish, impermeable to moisture. It is an excellent varnish, for preserving iron and steel from rust: and it may be removed by a soft brush, dipped in oil of turpentine. A solution of caoutchouc, in five times its weight of oil of turpentine, and this solution, mixed with eight times its weight of drying linseed-oil, by boiling, forms the varnish usually applied to air-balloons.—*Or,* Digest 1 oz. of caoutchouc, cut into small pieces, in 32 oz. of naphtha; and, when it is dissolved, strain the varnish through a linen cloth.

*Oil of Tar, for Common Varnishes,* may be employed instead of naphtha.

*Varnish for Iron or Wood.*—Dissolve ¼ pint of alcohol in a gallon of wood tar.

*Red Varnish, (for Cabinet-work and Violins.)*—In 1 quart of alcohol dissolve 2 oz. of Strasburgh turpentine, 1 oz. of mastich and of choice benjamin, 2 oz. of seed lac, and 4 oz. of gum sandarac. *Or, (for Metals.)*—In 1 quart of alcohol dissolve 6 oz. of Venice turpentine, 4 oz. of brown rosin, 2 oz. of shell lac, and 8 oz. of gum sandarac.

*Spirit Varnish, for Colours on Wood.* In a matrass, capable of containing two Paris pints of liquid, put a pint, or about 2 lbs., of good spirit of wine, and throw in 4 oz. of shell lac, broken into small bits, together with 2 oz. of gum sandarach, and 1 oz. of gum mastich in tears, grossly powdered; you also add 1 oz. of oil of spike, and place the vessel upon a ring of straw, laid upon the bottom of a boiler filled with water; the whole must be then heated in a furnace over a charcoal fire, and the contents be stirred from time to time, until the gums are entirely melted; but care is to be taken that the spirit of wine be not heated to its boiling-point. This varnish, when cold, is fit to mix with lamp-black, vermilion, or other opaque colours; but, when it is to be used alone, to give a fine polish, it should be filtered, either through cotton or filtering-paper.

*Varnish for out-door Painting.*—Boil half a gallon of linseed-oil in an iron pot, for an hour, and then lay in it a round of crumb of bread, to absorb the fat, and boil some time. Take out the bread, and put in a lb. of powdered rosin gradually, and stir with an iron spatula. Add 4 oz., or more, of the spirits of turpentine, and strain it. It bears weather, wear, and hot water. The same may also be made of 1 oil of turpentine and 4 rosin, well boiled. *Or*, by boiling 16 drying linseed-oil, 8 of gum sandarac, and 1 of oil of turpentine.

It is usual, in the manufacture of spirit varnishes, to mix glass or sand with the resin, for the purpose of affording ready access of the alcohol to all parts of the solid mass. M. Ferrari, however, recommends that, in place of these substances, coarsely-powdered charcoal should be used; for the glass or sand frequently tends to aggregate the resin at the bottom of the vessels and protect it from the solvents, whilst, on the contrary, the charcoal rather tends to raise and divide it. The most advantageous proportion appears to be about 1 oz. of charcoal to 1 lb. of the spirits or the oil of turpentine.

*To Varnish Silk.*—If the surface of the silk be pretty large, it is made fast to a wooden frame furnished with hooks and moveable pegs. A certain quantity of a soft paste, composed of linseed-oil, boiled with a fourth part of litharge, white of Troyes, Spanish white or tobacco-pipe clay, lamp-black and litharge, is then prepared, in nearly the following proportions: tobacco-pipe clay, dried and sifted through a silk sieve, 16 parts; litharge, ground with water, dried and sifted in the same manner, 3 parts; lamp-black, 1 part. This paste is then spread in an uniform manner over the surface of the silk, by means of a long knife, having a handle at each extremity.

In summer, 24 hours are sufficient for drying, and, when dry, the knots produced by the inequalities of the silk are smoothed with pumice-stone. This operation is performed with water; and, when finished, the surface of the silk is washed. It is then suffered to dry, and copal varnish applied.

If it be intended to polish this varnish, it will be proper to apply a second stratum; after which it is polished with a ball of cloth and very fine tripoli, or with a piece of strong cloth only. The varnished silk which results from this process is very black, exceedingly pliable, and has a fine polish. It may be rumpled any way without retaining any fold, or the mark of a fold.—*Tingry.*

Varnished silk, which has a yellowish colour, is prepared with a plain varnish. The silk is covered with a mixture of three parts of boiled oil of poppy, and one part of fat copal varnish, which is spread with a coarse brush, or with a knife. Two coats are sufficient, when the oil has been freed from its greasy principles over a slow fire, or when it has been boiled with a fourth part of its weight of litharge. The inequalities are removed by pumice-stone and water; after which the copal varnish is applied. This simple operation gives a yellow colour to white silk, which arises from the boiled oil and the varnish.

*Varnish or Lacker for Brass-work.*—Take spirit of wine, and, to concentrate it, throw in dry potash and decant, leaving the sediment. To remove all the potash, dissolve some alum in it, and again decant. Then, to a pint of spirit add 3 oz. of powdered shell lac, and digest, in a moderate heat, and again decant and strain. Some gamboge gives it a yellow colour, and annotto an orange; or 2 of gamboge and 1 annotto a golden colour. For silver or tin-leaf, more colour should be infused. Before putting on the lacker, polish with emery and finish with tripoli. The brass is heated over a charcoal fire, and the lacker warmed, and put on with a camel-hair brush, in one even wash.

Great care and circumspection should be used in the preparation of almost every kind of varnish. Not only are *rectified spirit of wine* and *oil of turpentine* converted into inflammable vapour, but the *fixed oils* expose to similar hazard when subject to high temperatures.

VEGETABLE CHEMISTRY.—The principles of which vegetables are composed, if we pursue their analysis as far as our means have hitherto allowed, are chiefly carbon, hydrogen, and oxygen. Nitrogen is only present in small quantity. Potash, soda, lime, magnesia, silex, alumine, sulphur, phosphorus, iron, manganese, and muriatic acid occur, though in small and very variable proportions. Every distinct compound which exists already formed in plants, and which is capable of separation without suffering decomposition, is called a *proximate*, or *immediate principle*, of vegetables. Thus sugar, starch, and gum, are proximate principles. In some cases, a particular principle is mixed with such a variety of others, that a distinct process is required for its separation. The reduction of the proximate principles into their simplest parts constitute their *ultimate analysis*. By this means, the quantity of oxygen, carbon, and hydrogen present in any compound is ascertained. The method by which this is accomplished is, to convert the whole of the carbon into carbonic acid, and the hydrogen into water, by means of some compound which contains oxygen in so loose a state of combination as to give it up to those elements at a red heat.

The substance employed is the *peroxide of copper*, which, if alone, may heated to whiteness, without parting with oxygen; whereas it yields oxygen readily to any combustible matter with which it is ignited. It is easy, therefore, by weighing it before and after analysis, to discover the precise quantity of oxygen which has entered into union with the carbon and hydrogen of the substance submitted to examination. From ultimate analysis, the three following conclusions are drawn.

1. A vegetable substance is acid, when it contains more than a sufficient quantity of oxygen for converting all its hydrogen into water.

2. It is always resinous, oily, or alcoholic, &c. when it contains less than a sufficient quantity of oxygen for combining with the hydrogen.

3. It is neither acid nor resinous, but in a state analogous to sugar, gum, starch, or the woody fibre, when the oxygen and hydrogen which it contains are in the exact proportion for forming water.

Thenard has divided the proximate principles into five classes. The first includes the vegetable acids; the second, vegetable alkalies; the third, those substances which contain an excess of hydrogen; the fourth, those, the oxygen and hydrogen of which are in proportion for forming water: and the fifth, those bodies which, so far as is known, do not belong to either of the other divisions.

Under the title of *vegetable alkalies* are comprehended those proximate principles which are possessed of alkaline properties. They all consist of carbon, hydrogen, oxygen, and nitrogen, and they are decomposed with facility by nitric acid, and by heat; and ammonia is always one of the products of the destructive distillation. As they agree in several of their leading chemical properties, the mode of preparing them, with slight variation, is general. The substance containing the alkaline principle is digested, or, more commonly, macerated, in a large quantity of water, which dissolves the salt, the base of which is the vegetable alkali. On adding some more powerful salifiable base, such as potash or ammonia, or boiling the solution, for a few moments, with lime or pure magnesia, the vegetable alkali is separated from its acid; and, being in that state insoluble in water, may be collected on a filter, and washed. To purify it from certain oleaginous, resinous substances, and colouring matters, it is mixed with a little animal charcoal, and dissolved in boiling alcohol. This solution is filtered while hot, and evaporated to dryness, which affords the alkali in a state of perfect purity. Upwards of twenty of these bodies have already been investigated; as morphia, cinchonia, quinia, strychnia, brucia, veratria, and sanguinaria.

VEGETATION.—A seed consists of 2 parts—the *germ* of the future plant, endowed with a principle of vitality; and of the *cotyledons*, or *seed-lobes*, both of which are enveloped in a common covering or cuticle. In the germ are two parts—the radicle and the plumule—the former of which is destined to descend into the earth, and the latter to ascend and form the plant or tree. For this, warmth and moisture are essential, as well as air.

The office of the seed-lobes is to afford nourishment to the young plant, until its organization is so far advanced that it may draw materials for its growth from extraneous sources. For this reason, seeds are composed of highly-nutritious ingredients, and the chief is starch, in addition to which they frequently contain gluten, gum, vegetable albumen or curd, and sugar.

With respect to the food of plants, the chief source from which plants derive the materials for their growth, is the soil; and, however various the composition of soil, it consists, essentially, of two parts. *One*, a certain quantity of earthy matters, such as silicious earth, clay, lime, and sometimes magnesia; and *the other* the remains of animal and vegetable substances, which, when mixed with the former, constitute common mould. A mixture of this kind, moistened by rain, affords the proper nourishment of plants.—*See* PLANTS, &c.

Without water, plants speedily wither and die. But, necessary as is this fluid to vegetable life, it cannot yield to plants a principle which it does not possess. The carbonaceous matter, which accumulates in plants, may with certainty be attributed to the atmosphere, since we know that carbonic acid exists there, and that growing vegetables have the property of taking carbon from that gas. When plants are burnt, their ashes are found to contain saline and earthy matters, the elements of which, if not the compounds themselves, are supposed to be derived from the soil.

*To condense Vegetables.*—Boil them over a fierce wood fire, so as to preserve their colour when completely cooked; grind them into a pulp, by such means as are used to crush apples for cider; then press them, (being first put into hair bags, or treated as grapes are in wine countries) till all the fluid matter is separated. Then let the substance be rammed hard into carefully-glazed air-tight jars, or tin cases. If jars are used, they may be sufficiently secured, by having a piece of caoutchouc tied over them. The preparation for use is accomplished by adding to it a sufficient quantity of milk, water, lime-juice, &c. and warming it up.

Vegetables are in season in England as under:

| | |
|---|---|
| Artichokes | July to Oct. |
| Asparagus | May to July. |
| Beans, Windsor, &c. | Mid. to Sept. |
| Beans, French | Mid. & Onward. |
| Beans, Scarlet | July to Oct. |
| Borcole, or Scotch Kale | November, and all the winter. |
| Brocoli | October & ditto |
| Cabbage | May, and all summer. |
| Cabbage, red | July to Sept. |
| Carrots | May till winter. |
| Cauliflowers | June to August. |
| Celery | June till March. |
| Corn Salad | May to July. |
| Cucumbers | June to Sept. |
| Endive | June, & all the winter. |
| Leeks | September, and all the winter. |
| Lettuces | April, and all the summer. |
| Onions | June to Nov. |
| Parsnips | August, and all the winter. |
| Peas (green) | June to Sept. |
| Potatoes | May, and all the year. |
| Radishes | March to July. |
| Salsafy & Scarzonera | July & August. |
| Sea-kale | April and May. |
| Spinach (spring) | March to July. |
| Ditto (Winter) | Winter and Sp. |
| Turnips | May to Sept. |
| Turnip-tops | Feb. to May. |

All vegetables are best, if dressed as soon as gathered; and, are in their greatest perfection just before they begin to flower.

Herbs, of all kinds, should be gathered in a dry day; and when the roots are cut off, and the herbs are perfectly well cleaned from dust and insects, &c. they should be divided into small bunches, and dried very quick in a Dutch oven. They should then be kept in paper bags, or powdered, and kept in well-corked bottles. Sweet and savory herbs are best in season from May to August, according to their kinds. The flavour and fragrance of fresh herbs are much finer than of those that are dried.

No vegetable leaves, &c. should be kept more than a year. They should be gathered when no dew is upon them. Roots, before their stems or leaves expand. Bark, in spring. Leaves between the flowering and seed maturing. Flowers, as soon as opening. Seeds, when they are ready to drop.

Drying should be quick, but heat so regulated as not to impair the colours. Roots should be kept in dry sand.

When leaves are to be used as powders, these should be kept in close bottles.

Vegetables are pickled in vinegar, but are to be soaked in salt and water for some hours, then drained, and spices added, after which, boiling vinegar is poured upon them. After four days, the vinegar is boiled with the spices, and the vegetables are again immersed.

In preserving fruits in syrup, when moist sugar is used, the syrup is clarified with white of eggs; when refined sugar, it is only melted by heat, in one-third its weight of water, which will evaporate as the syrup is taken up with a large slice, and dropped into the pan again, until it forms a broad sheet as it falls, boiled for a *candy* height, but only imperfectly for a weak candy height. When the boiling is continued, the syrup is boiled to a *full* candy height, and stirred till cold, and forms a dry powder.

To preserve fruits, they are covered well in the syrup, to the weak candy height, poured hot upon them, and, as the juice of the fruit weakens the syrup, it must next day be poured off, boiled again to the same height, poured on the fruit; and this is repeated with juicy fruit, even three or four times, till the syrup is no longer weakened by the juice.

To preserve fruits in sugar, if the fruit is very succulent, it is to be soaked some hours in hard, or weak alum-water. The fruit, mixed with syrup, is boiled to candy height, but half cold. And after some hours, the syrup, weakened by the juice of the fruit, is again boiled, and poured on repeatedly, if necessary. The fruit is then taken out, and drained.

Fruits are preserved also in brandy, or other spirits, but the juicy fruits ought to be gathered before ripe, and first soaked in very hard or alum-water. As the moisture of the fruit weakens the spirit, it ought to be very strong, and 5 oz. of sugar added to every quart.

Some vegetables and animal substances are preserved in olive-oil, in jars closely luted.

*Vegetable acids.*—The developement of acids in vegetables is principally occasioned by the presence of alkalies. We find, in fact, the acids almost always neutralized altogether, or, in part, by various alkalies, as lime, potash, soda, magnesia, and sometimes by vegeto-alkalies: and the latter have never been found in a free state in the vegetable kingdom.

The alkali which plays the greatest part, in this respect, is certainly lime, for it is most generally diffused, is most abundant at the surface of the earth, and powerfully attracts acids. It does not, certainly, enter into the organic kingdom in the state of lime, but as carbonate, which, without exerting any deleterious action on vegetables, still retains sufficient alkaline force to determine the formation of acids, and particularly the oxalic, which it prefers to all others.

We may thus explain the effect of calcareous manure on vegetables. Immediately after its introduction into the organs of plants, the carbonate of lime determines the developement of an acid which decomposes it, and sets its carbonic acid at liberty, which, by means of light, is turned to account in the vegetable kingdom. From hence it may be concluded, that calcareous manures fill two important functions—1. The division of the soil. 2. The nutrition of the plants.

VEGETO-ACID, is made from linen, or hemp, immersed in strong sulphuric acid. The pulp is washed in water, and the black matter is saturated with carbonate of lead, which lead is precipitated by a current of sulphuric hydrogen. The result is gum, which, boiled with sulphuric acid and water, becomes sugar and the acid. They are separated, by digestion and evaporation, into spirits and ether.

VENICE SOAP, AND MOTTLED CASTILE SOAP, are merely olive-oil and soda, with a little sulphate of iron, in solution, or sulphate of zinc.

VENOMOUS SERPENTS, form about a fifth of the whole class of snakes, and are distinguished by two long poison-fangs, which take the place of the first or exterior of the three rows of teeth, found in the upper-jaw. At the root of these fangs is situated a small sack, containing the venom, and opening into the fangs, through which it is ejected by the pressure caused by the action of biting. The extraction of the fangs, or the removal of the sack, destroys the power. The symptoms are:—pain in the bitten part, extending towards the heart, stupor, cold sweats, pallor and lividity of countenance, and gangrene of the bitten part. The best treatment is to put a ligature upon the limb that has been bitten, between the wound and the trunk of the body, and apply a wine-glass, from which the air has been exhausted, (by burning a little spirit within it,) as a cupping-glass, over the wound; or to cause the wound to be sucked by a person whose lips and tongue are not chapped. Animal poisons, of this description, are innocuous when taken into the stomach, although their action is so powerful, and often fatal, when they are introduced by a wound, or inoculation. For the stings of bees, wasps, and other insects, the part affected should be bathed with the tepid spirit of Mindererus.

The coloured snakes of Great Britain are perfectly harmless, and we have but one of the venomous species.

VENTILATION, so very important to health, cleanliness, and luxury, may be rendered universal, by carrying a tin-pipe, of an inch bore, from the corner of the ceiling of any room, to the open air at the top of the house. Small rooms, bed-chambers, &c. may thus be rendered sweet and healthful, at the expence of a few shillings. The top may be bent to keep out wet, or be provided with a small cowl to turn with the wind.

Ball-rooms, places of public-meeting, eating-rooms, &c. may be refreshed in like manner, with pipes of 2-inch bore, and, above all, stage-coaches, by a pipe in the roof, would be relieved from their noisome odour. Heat may also be conveyed from any lower apartment to an upper one by similar means, and even hot-air, if the tube is continued with a length of air through a fire-place, and an opening made into the room to be warmed.

In certain cases, perfect ventilation may be effected by pipes from the roof to the floor, in an opposite corner to that in which the ascending pipe is placed in the ceiling.

When much bending is necessary, the pipe may be made of lead, or caoutchouc.

As half the diseases of mankind arise from sitting and sleeping in close small rooms, which even chimneys relieve only to their own height, the value of this cheap and effective mode of ventilation is inappreciable.

Thorough ventilation is necessary to the preservation of health. It is not enough that we have *air*, we must have *fresh air*; for life is supported by the air during the act of breathing. A man takes into his lungs nearly a pint of air each time he breathes; and, at rest, he makes about twenty inspirations in a minute; in action from 30 to 40: that is, $2\frac{1}{2}$ to 4 gallons per minute, or a cubic foot in 2 minutes, or a room of 800 cubic feet in a day. Thus, a stage-coach, 6 feet by 6, and $4\frac{1}{2}$ high, *i. e.* 162 feet, is vitiated, in 52 minutes, by 6 passengers, and in an hour and a quarter by 4. Every coach should, then, have a lanthorn in its roof, for constant access of air. In the lungs, the air is exposed to the action of the venous, or nitrogenated blood, which changes its oxygen gas into carbonic-acid gas, unfit to support animal life. While in the lungs, the air receives so much heat as makes it specifically lighter than the atmosphere; it consequently ascends, and thus secures a pure draught. By shutting out the external air from our houses, we prevent the escape of the deteriorated air, and breathe again and again the contaminated air.

The following simple method of ventilating large halls, theatres, &c. has been found by M. Van Marûm to answer most effectually:—Let a common Argand lamp be suspended from the roof, and kept burning under a funnel, the tube of which is carried out into the open air, and furnished with a ventilator.

VENTRILOQUISM.—The art of the ventriloquist consists merely in drawing a long breath, and breathing it out slowly and gradually, dexterously dividing the air, and diminishing the sound of the voice by the muscles of the larynx and the palate.

VERDIGRIS, or acetate of copper, is a preparation made by the cake, or marc of the wine-presses in the South of France. Thin plates of copper are exposed for some time to their action, and being coated with verdigris, the operation is finished by pressure into loaves of the substance. It is a tonic and emetic, and useful in epilepsy. Externally, it is applied to ulcers, and made into a collyrium.

VERMILION, is Ethiop's martial, heated red-hot, and sublimed; or, red sulphuret of mercury. In a cake it is *cinnabar*, but, in powder, *vermilion*.

*Chinese Vermilion.*—Take quicksilver and sulphur, in the proportion of sixteen parts of the former, to four of the latter. After powdering the sulphur, place the two ingredients in an earthen jar, the outside of which, to exclude the air, must be plastered with mud and salt, to the thickness of three inches and a half; place an iron cover on the mouth of the jar, and let it be kept constantly moist. Place the jar in an oven, early in the morning, and at the same hour on the next morning extinguish the fire; at noon take it out of the oven, and, when cold, break the jar in pieces, and take out the contents. Pick out the dross, and then reduce the rest to a fine powder: let this be poured into a large jar full of water. After a time, a thin coating will be found on the surface of the water, which must be skimmed off, and a portion of the water let off; in a short time this process must be repeated, and the third time let all the water be drained off. The sediment is then exposed to dry, and taken out in cakes.

VERTEBRA, the name of the little bones which compose the spine. They are short, thick, angular, twenty-four in number, placed one above the other. Each vertebra has commonly seven processes. The first of these is the *spinous* process, which is placed at the back part of the vertebra, and gives the name of *spine* to the whole of this bony canal. Two others are called *transverse* processes, from their situation with respect to the spine, and are placed on each side of the spinous process. The four others, which are called *oblique* processes, are much smaller than the other three; and they are called *oblique* processes, from their situation with respect to the processes with which they are articulated. In every vertebra is a hole large enough to admit a finger, and these holes correspond with each other, and form a *long bony conduit*, for the lodgment of *the spinal marrow*. Besides this great hole, there are four notches on each side of every vertebra, between the oblique processes and the body of the vertebra. Two of these notches are at the upper, and two at the lower part of the bone. Each of the inferior notches, meeting with one of the superior notches of the vertebra below it, forms a foramen; whilst the superior notches do the same with the inferior notches of the vertebra above it. These four foramina form passages for blood-vessels, and for the nerves that pass out of the spine.

The vertebræ are united together by means of a substance, compressible like cork, which forms a kind of partition between them, and the change which takes place in these cartilages, in advanced life, occasions the decrease in stature, and the stooping forwards. The cartilages become shrivelled, and lose, in a great measure, their elasticity. But, these cartilages are subject to a temporary diminution, from the weight of the body in an erect posture; so that we are taller in the morning than at night. In tall, young people, it is nearly an inch; but, in older or shorter persons, less. Besides these cartilages, there are many strong ligaments, which unite the bones of the spine.

VERVAIN, is an ordinary-looking weed, but was employed by the ancients in religious ceremonies, and no incantation or lustration was perfect without this plant. It had ascribed to it the power of curing bites of rabid animals, arresting venom of serpents, reconciling antipathies, friendship, &c.

The moderns find it febrifuge, vulnerary; externally, useful as a rubefacient in rheumatism, and other pains of the joints. The root, worn round the neck, is said to cure scrofulous and scorbutic affections. The *Jamaica vervain* is cathartic, deobstruent, and emmenagogue.

VICE, used by smiths, is a common instrument with two cheeks, made to hold or bite by a screw of power.

The vice for glaziers is one by which prepared lengths of lead are drawn through it in slips for windows, the hole, or tool, being the form of the slips, and the force applied by a winch handle.

VINE.—The common grape grows in temperate climates; the extreme points at which it is successfully cultivated, in the open air, being in Persia, in lat. 25°, and the Rhine in lat. 52°. It succeeds best if the soil be light, and rather dry than humid. Most of the vineyards in France are in a soil both clayey and calcareous; but excellent wines are produced in granitic, and also in volcanic districts. The varieties are innumerable, differing in form and size, colour, taste, consistence, fragrance, the size of the seeds and bunches, &c. In planting, to produce the wine, it is important to select such as arrive at maturity at the same period. It is universally propagated by cuttings, with a portion of two-years old wood, or short, with only one bud, or one bud and half a joint. New varieties can only be obtained from seed; and a seedling will blossom in its fourth or fifth year.

Sweet wines are made from sweet-berried grapes, allowed to remain on the plants till over ripe, and that wine is the strongest, and has most flavour, in which both the skins and stones are bruised and fermented. The varieties most esteemed for wine-making have small berries and bunches, with a rough taste. In certain localities, the vine lives only 20 or 30 years; but, under favourable circumstances, it may last several hundred. Heavy rains, drought, or a sudden fall of temperature at maturity, may produce the partial, or even total destruction of the vintage. Hail often does great injury, even when the stones are of small size. Most varieties bear only once in the season, some oftener, especially in warm climates.

Grapes, when ripe, are wholesome, and they are sometimes the sole article of diet. They contain sugar, mucilage, and a little acid. Better dessert-grapes are produced in England than in any other part of Europe; at once richer in flavour and thinner in the skin. The varieties on the continent are few; and the best, as the Muscats and Frontignacs, have been obtained from England. The Chasselas, or Muscadine, is almost the only eating grape known in the Paris fruit-market. England has not only produced the finest varieties, but they acquire a higher flavour here than elsewhere, owing to the perfection of hot-houses. In the south of Europe, grapes are often dried either by the sun or in a furnace, as *raisins*. The smallest are those of Corinth, known under the name of *Currants*.

Red wines are made exclusively from red or black grapes, while red or white are used indifferently for white wines.

As soon as fruit is gathered from a tree, or even from a single branch, cut off the leaves, and, if necessary, prune it for the next year. This early pruning assists to ripen the wood, without which no great crop can be expected. From the Black Hamburgh, a crop of fine ripe grapes may, by this means, be had, from the beginning of the season till Christmas. The only secret in ripening grapes in the open air is timely summer-pruning, and constantly keeping the fruit close to the wall. Open black muslin bags should be used, for protectors. The strongest bunches should be chosen, and freed from small and decayed berries before bagging.

*Vine on Wires downwards.*—A correspondent of the *Gardener's Magazine* has, by this mode, from one house, containing 17 rafters, produced upwards of 480 lbs. of superior fruit, which he states to be more than double the quantity he could ever procure from the old system of training to the glass.

*To stop Vines from bleeding.*—Let the part bleeding be forced into a sound potato; for, if any of the skin of the potato has been rubbed off, the sap of the vine will soon find its way to escape, and the vine will continue to bleed; but if the potato be free from any bruise, it stops the bleeding.—*See* WINE.

VINEGAR *(acetic acid)*, is found combined with potash in a great many plants. Almost all dry vegetable substances, subjected in close vessels to a red heat, yield it copiously. It is the result, likewise, of spontaneous fermentation. Strong acids, as the sulphuric and nitric, develope the acetic by their action on vegetables. Cabbages *sour* in water, making sour-crout; starch, also, in starch-maker's sour-water; and dough itself.

The varieties of acetic acids are five: 1. wine vinegar; 2. malt vinegar; 3. cider vinegar; 4. sugar vinegar; 5. wood vinegar. The following is the French method of making vinegar: The wine destined for vinegar is mixed, in a large tun, with a quantity of wine lees; and, the whole being transferred into cloth sacks, placed within a large iron-bound vat, the liquid matter is forced through the sacks by superincumbent pressure. What passes through is put into large casks, set upright, having a small aperture in their top. In these it is exposed to the heat of the sun in summer, or to that of a stove in winter. Fermentation takes place in a few days. If the heat should then rise too high, it is lowered by cool air, and the addition of fresh wine. In summer, the process is generally completed in a fortnight: but, in winter, double the time is requisite. The vinegar is then run off into barrels, which contain chips of birch-wood, and in about a fortnight it is found to be clarified.

In Great Britain, vinegar is usually made from malt. By mashing with hot water, one hundred gallons of wort are extracted, in less than two hours, from one boll of malt. When the liquor has fallen to the temperature of 75° Fahr., four gallons of yeast are added. After thirty-six hours, it is racked off into casks, which are laid on their sides, and exposed, with their bung-holes loosely covered, to the influence of the sun; but in winter, are arranged in a stove-room, and in three months this vinegar is perfect. For domestic use, the above liquor is racked off into casks placed upright, having a false cover, pierced with holes, fixed at about a foot from their bottom. On this a considerable quantity of *rape*, or the refuse from British wine, or a quantity of low-priced raisins, is laid. The liquor is turned into another barrel every twenty-four hours, in which time it has begun to grow warm. Sometimes the vinegar is fully fermented, without rape, which is added towards the end for flavour.

Cider is another source of vinegar. The family method is as follows:—The vinegar barrel, in summer, is placed in the garret, or on the sunny side of a building, and in winter in a room where it does not freeze. The refuse cider, already sour, or the remnants of the family, are added to some good vinegar in the barrel, or to the *mother* of vinegar, as it is called. This mother of vinegar is a white or yellowish ropy coagulum, of a mucilaginous appearance, which is formed in the vinegar, and acts as a ferment upon cider not yet thoroughly acidified. The fermentation is often aided by putting into it a piece of dough, or by adding molasses. In a few weeks the vinegar is formed.

The vinegar from sugar is made as follows:—Ten pounds of sugar are added to eight gallons of water, with yeast and raisins or grape cuttings, to assist in the fermentation; twelve pints of bruised gooseberries, or other fruits, are added; and, by a process similar to that for cider, good vinegar is soon produced.

By distillation the colouring matter in mucilage is separated; but the fragrant odour is generally replaced by an empyreumatic one.

The specific gravity varies from 1·005 to 1·015.

The *Vinegar of Wood*, as it comes over in the first distillation, with its tar and empyreumatic oils, is extensively used in preserving meat and all animal substances. A single dipping, or washing, destroys all tendency to putrescence and decomposition, and operates like its smoke, in curing hams, fish, &c. and evidently on the same principle.

It is also found to be highly efficacious in checking of putrescence in wounds and ulcers, and in arresting scrophula, and obstinate local inflammations.

It is prepared by the destructive distillation of any kind of wood. It is then re-distilled in a copper still, leaving one-fifth residuum of tough tarry matter. The product, brown vinegar, is then distilled a third time, and absorbed by lime, dried, and torrified as calcareous salt. This is decomposed by sulphuric acid, and the product is pure acetic acid. At 75°, one part with 11 of water is the common distilled vinegar of medicine.

Pyroligneous acid is prepared, quite colourless, on a large scale at Battersea, and at 50° of the Excise autometer, is seven times stronger than table, or pickling vinegar, and requires seven volumes of water for culinary purposes. A piece of meat, or a whole animal dipped in it, or sponged, or brushed with it, remains sweet and free from putrescence for months or years.

*Four-thieves Vinegar.*—In two pints of strong acetic acid, for 7 days, digest 1 oz. of rosemary-tips and of sage-leaves, ½ an oz. of lavender-naps, and 1 scruple of cloves; (some add half a clove of garlic). Press well, and filter.

VIOLET, SPIRIT OF.—In two pints of alcohol infuse 4 oz. of Florentine orrice-root.

VITRIOL, WHITE, is composed of sulphuric acid and zinc. Then, if, in a solution of the former substance in water, we suspend a piece of metallic zinc, the acid will abandon the lead, which will resume its metallic form and unite with the zinc. The lead is precipitated upon the zinc in an arborescent form. But, if a solution of acetate of lead be mixed with a solution of sulphate of zinc, the acetic acid will, as before, abandon the lead to unite with the zinc; but, at the same moment, the sulphuric acid will combine with the lead, and form with it an insoluble compound, which will be precipitated in the form of a heavy white powder. Sugar of lead, or acetate of lead, is a compound of 50 parts of acetic acid and 112 parts of lead in the state of an oxide. White vitriol, or sulphate of zinc, is composed of 40 parts of sulphuric acid, and 41 parts of zinc, also in the state of oxide.

*Blue Vitriol* is the sulphate of copper, obtained simply by evaporating the waste water of mines; or, sometimes, by roasting copper pyrites. In other cases the sulphate is converted into copper, by immersing iron in the water. It is often used as an emetic, and applied to indolent ulcers, and to the eyes as a collyrium.

*Green Vitriol, or Copperas*, is protosulphate of iron, made by exposing iron pyrites to air and water. It is then digested with iron turnings, to get rid of the excess of sulphuric acid.

*Sweet Spirit of Vitriol*, (or vitriolic ether). Mix a lb. of alcohol and of sulphuric acid, and heat till a thick scum forms; then cease.

*Sweet Elixir of Vitriol.*—Mix 8 oz. of the preceding with 12 oz. of compound tincture of cinnamon.

VOLCANIC ISLANDS.—A very brilliant representation, in miniature, of the manner in which such volcanic groups of islands as the Azores emerged from the ocean, may be produced by immersing a bottle of phosphuretted hydrogen in the water of a pneumatic cistern, and then removing the cork. As the bubbles of gas rise to the surface, and come in contact with the open air, they instantly take fire, and exhibit the appearance of so many cones of flame ascending spontaneously.

WALNUT.—The common European walnut is a lofty and beautiful tree. The nuts are highly esteemed, and the oil expressed from them serves a very important purpose in the preparation of fine colours. It is preferred on account of the complete and rapid manner in which it dries, and the facility of obtaining it perfectly limpid, by diffusing it upon water in large shallow vases. In copper-plate printing, it is considered indispensably necessary for a fine impression, either in black or colours. By boiling the husks when beginning to decay, and the bark of the roots, a substantial dark-brown colour is obtained, which is used by dyers for woollens, and also by cabinet-makers to stain other species of wood. The fruit, in a green state, before the shell hardens, is much used for pickling, and also as an adulteration of soy-sauce. Before mahogany was imported so abundantly, the wood was employed, almost exclusively, in cabinet-making. It is preferred for the stocks of muskets, as it is lighter, in proportion to its strength and elasticity, than any other wood. Great quantities of wooden shoes are also made of it. The sap of the walnut yields sugar. The kernels of the seeds are cooling, but difficult of digestion. They yield, by expression, half their weight of oil. The peel of the fruit is used in dyeing brown. The leaves are detersive, diaphoretic, anti-syphilitic. The inner bark is emetic, and cathartic. The spongy substance in the nut astringent. Walnut-oil also forms an excellent *soap*, introduced by the late Dr. Reece, of Piccadilly, and preferred to all other soap, as a softener and cleanser of the skin.

*Walnut Water.*—Dr. Sully, of Wiveliscombe, a very eminent medical practitioner, has published a mode of preparing this article, which has been found so effectual a remedy in subduing nausea and vomiting:—Take a quarter of a peck of walnuts at the time they are fit for pickling; bruise them, and with 4 oz. of fresh angelica seeds, put them into an alembic, with a bottle of French brandy, and enough of water to prevent empyreuma, or burning; distil from this mixture a quart, which is called walnut-water, and administer a wine-glassful to the patient, to be repeated every half hour till the vomiting ceases.

WARD'S PASTE, for internal bleeding, is 1 black pepper, 1 elicampane-root, 3 fennel-seeds, 3 loaf-sugar, beat together, and 3 honey added.

*Ward's Paste (for Piles and Fistula).* Mix well, in 2 lbs. of honey, 2 lbs. of white sugar, 1 of black pepper, and of elicampane-root, and 3 lbs. of fenugreek seed. The size of a nutmeg three or more times a day.—*See* PILE OINTMENT, 1041.

WARMING DWELLING-HOUSES, &c.—The principal methods of warming buildings, now in use, besides the imperfect and wasteful means of coal-fires, are the following:—

1. By heated atmospheric air, very objectionable.
2. By the circulation of hot-water.
3. By the circulation of steam, adapted only for factories.

By warming with *hot-water*, the most essential benefits arise, it being effected by the radiation of heat, from the pipes containing it, which may be hermetically sealed, and placed at any distance from the boiler, and so disposed over the apartment, that the temperature cannot fail of being constant, uniform, genial, and the air perfectly fit for the purposes of respiration; for, as the atmosphere, when hot-water is the medium of conveying heat, comes into contact with, and receives heat from, a substance at the low temperature of about 200 degrees, it cannot be deteriorated, as that temperature is not sufficiently high to separate or change its constituents. The temperature of the apartment may be more easily regulated by this mode than by any other, in consequence of that remarkable quality possessed by water, namely, motion of its particles on the introduction of heat, which has not, until very lately, been noticed with a view to deriving any benefit from it, for, as soon as the temperature of the water is raised, motion takes place in the pipes attached to the boiler, a current passes from it into the extremity of the pipe, with a rapidity proportioned to the degree of heat communicated, it gives out warmth as it passes along, and returns to the boiler to be re-heated, and then proceeds again as before.

If it be desired to raise the temperature of a suite of apartments but a few degrees above the external atmosphere, the water may be made to circulate, and kept constantly circulating, at a low temperature, by a diminished supply of fuel to the boiler, or the introduction of valves.

Hot-water is an excellent means of keeping a reservoir of heat; for, although it forms an excellent medium for the purpose of carrying heat to certain points, it likewise retains it for a length of time, giving it out slowly, notwithstanding it can be made to receive it very fast.

The hot-water system is found to require less attention than a common kitchen-fire, for, when the fuel is once ignited under the boiler, we are certain that all the heat it will produce is conveyed to the point where it is required without any further attention, and on this account the hot-water system is invaluable where it is desirable to keep a constant and uniform temperature during the night without the necessity of a fatiguing attention to the fire, for, in the coldest weather, the whole of a large mansion will be found the next morning at the same temperature that it was the previous night, without any other trouble than that of igniting and leaving the fuel to perform its own office of sending the water on its endless journey. The pipes employed for this purpose will last for ages, and the boiler for many years.

Steam may, however, be employed with advantage where a very high temperature is required, as in drying-rooms, for instance, where a large quantity of very wet articles, &c. require to be dried with great rapidity, and where the magnitude of the work will admit of the expense attending the very complicated apparatus required; but, even then, it is far inferior to hot water for producing a well-regulated atmosphere, suitable for the respiration of man, beast, or plant, more especially when the apparatus is required upon a moderate scale.

It was reserved for Major-General Viney to produce a boiler calculated to supply the deficiency hitherto felt. Simple in its construction, yet made on strictly philosophical principles; affording sufficient room for the perfect combustion of fuel, yet occupying an inconceivably small space: not like other boilers, requiring a great erection of brickwork, for this needs none, yet is perfectly safe; exposing a large surface to the action of the fire, yet containing but a small quantity of water; as easily managed as a parlour-fire, yet producing results far surpassing those of the glowing furnaces that disgrace our kitchens; its power is unlimited, yet is equally applicable to the breakfast-table, and to a power far beyond what it is possible to construct an engine, and far more cleanly in its use, but effective in its application. It will, says Mr. Dewhurst, ere long, produce a gigantic revolution in our domestic comforts, cheer and enliven those sad comfortless abodes of the destitute, whose looks check the warm current of happiness in our veins, and enliven our finer feelings of benevolence and compassion to their sufferings, and whose damp pestilential atmospheres load their lungs with suffocating sensations.—*Dewhurst.*

WARP, is the lengthwise threads in a loom, through which the weaver passes the woof with his shuttle. The threads of the warp are raised either alternately, or in sets, so as to form patterns, and the warp and woof are often of different materials.

WARTS AND CORNS. The bark of the willow-tree, burnt to ashes, mixed with strong vinegar, and applied to the parts, will remove warts, corns, or excrescences.

WASH BALLS *(For Grease Spots)*, are made of dry Fuller's earth, lemon-juice, and pearl-ashes, dried in the sun; and are used by wetting the spot, drying, and washing off.

WASPS, THE STING OF.—The best remedy is a very strong brine of salt and water.

WASTE LAND.—Grey lichens indicate the most barren kinds of soil; and such land, planted, will only produce bushes. Coarse bent-grass denotes a stiff poor soil, inclined to wet; fit for the alder, native willow, and spruce, with a few birches. Dry soil, with thick and healthy heath, and without grey moss or bent-grass, is capable of producing a good average crop of larch, birch, and Scotch pine. Oaks, likewise, may be planted in it with success; but it is too poor for the ash, elm, beech, or sycamore. Broom is an unequivocal criterion of superior fertility. The furze or whin springs up on the best, as well as on the worst, of soils: when dwarfish, the soil is poor; when gigantic, dry and rich. Abundance of fern indicates the most fertile quality.

WATCH-MAKING.—The wheels in spring-clocks, and in watches, are urged on by the force of a spiral spring, contained in a hollow cylindrical barrel, or box, to which one end of a cord or chain is fixed, and lapping it round the barrel, for several turns outside: the other end is fixed to the bottom of a solid, shaped like the frustrum of a cone, known by the name of the *fusee*, having a spiral groove cut on it: on the bottom of this cone, or fusee, the first or great wheel is put.

The arbour, on which the spring-barrel turns, is so fixed in the frame that it cannot turn when the fusee is winding up: the inner end of the spring hooks on to the barrel arbour, and the outer end hooks to the inside of the barrel. Now, if the fusee is turned round in the proper direction, it will take on the cord or chain, and, consequently, take it off from the barrel. This bends up the spring; and, if the fusee and great wheel are left to themselves, the force exerted by the spring in the barrel, to unbend itself, will make the barrel turn in a contrary direction to that by which it was bent up. This force of the spring unbending itself, being communicated to the wheels, will set them in motion, and they will move with considerable velocity.

Their time of continuing in motion will depend on the number of turns of the spiral groove on the fusee, the number of teeth in the first or great wheel, and on the number of leaves in the pinion upon which the great wheel acts, &c.

The wheels, in any sort of movement, when at liberty, or free to turn, and when impelled by a force, whether it is that of a weight or of a spring, would soon allow this force to terminate; for, as the action of the force is constant from its first commencement, the wheels would be greatly accelerated in their course, and it would be an improper machine to register time or its parts. The necessity of checking this acceleration, and making the wheels move with a uniform motion, gave rise to the invention of the *escapement*, or '*scapement*, as it is commonly called. To effect this, an alternate motion was necessary, which required no small effort of human ingenuity to produce.

The *escapement* is that part of a clock or watch, connected with the beats which we hear it give; and these beats are the effects of the moving power, carried forward by means of the wheels in the movement to the last one, which is called the *swing-wheel* in a pendulum clock, and the *balance-wheel* in a watch.

The teeth of this wheel act on the pallets or verge, which are of various shapes, and which form the most essential part in a 'scapement; they drop from each tooth of the swing or balance-wheels, on their respective pallets, giving one beat or impulse to the pendulum or balance, in order to keep up or maintain their motion; and, were it not for the pallets. which alternately stop the teeth of the swing or balance-wheels, the motive-force would have no check.

Hence it is, that, by this mechanism of the 'scapement, the wheels in the movement are prevented from having their revolutions accelerated.—*See* CLOCK.

WATER, as a universal popular fluid, is rain, or spring, river, or well, snow, lake, or marsh water.

*Rain*-water contains some carbonic acid, and less carbonate and muriate of lime. In purifying the atmosphere of large towns, it imbibes noxious vapours and ought to be boiled.

*Spring*-water contains common and other salts, and is frequently so hard and devoid of soluble qualities as to curdle soap; a property increased by the bricks of wells.

*River*-water is often muddy.

*Well*-water improves by brisk draught and age of the well.

*Snow and Ice*-water are supposed to generate that horrid disease bronchocele, but, certainly, not every where; and lime or chalk in the district appears to be more pernicious in that respect.

*Lake and Marsh*-water contain materials for putrescence. Whatever may be the faults of water, it appears that urinary calculi do not contain any of its foreign ingredients.

In medical preparations, *distilled-water* is always used as a better solvent, since resins and vegetable infusions cannot be made by hard water. As hot water is kept on every fire, a simple apparatus, for condensing and collecting its steam, ought to be an accompaniment of every kitchen-fire.

Water is 1 volume of hydrogen, and 2 of oxygen; or, by weight, 8 of oxygen, and 1 of hydrogen.

Evelyn and Fletcher make a cubic inch of water 252·506 grains, and 1 grain of water 0·00396 of an inch; a grain being the 7000th of a ℔. avoirdupois, or the 5760th of a ℔. troy—that is, the *grain* is a standard, and the ℔. varies.

Water is to air as 1000 to 1·2, and a cubic foot of water weighs 1000 oz., (998·217); but a cubic foot of air but 525 grains, or 833 to 1. Hydrogen gas is 1-12th lighter than air, and oxygen gas nearly 1-5th heavier than air, a cubic foot being 627·812 grains.

Taking a cubic foot of water to be 1000 oz., a cubic inch weighs 0·5787th of an oz. But, if we take water at 55°, the weight of a cubic foot is 998·75 oz., and the inch but 0·57797.

Water freezes at 32°; but, if 1-8th of nitre be added, it will not freeze till 26°. If a fifth of sal-ammoniac, not till 8°; and if one-fourth salt, not till 4°. If equal parts of snow at 32, and of water at 172, are added together, it takes 70° of the heat or motion in the water to melt the snow; for the two are then but 32°. Their heat ought to have been the half of 204°, or 102, but being only 32°, the snow requires 70° to melt it. More motion was necessary, to render the crystals fluid, than merely to restore the heat.

When it shoots into ice, it forms, in the first place, a prism, not very regular in shape, but very long. From this primary prism other smaller ones shoot out on both sides, and always at angles of 60° and 120°. Hail is always crystallized in the form of two six-sided pyramids, applied base to base. Ice has been observed in crystals, having the form of a rhomboid of 120° and 60°.

In taking the solid form, water undergoes an enlargement of volume, from eight parts to nine; and this expansion even takes place previous to the congelation, during the reduction of temperature for six or eight degrees, the greatest density of water being about 40° Fah. In the act of freezing, too, the greater part of the air, which the water holds loosely dissolved, is expelled.

Water absorbs the aërial fluids, but in quantities very different. Of some of the acid gases, it absorbs many times its own volume. 100 cubic inches of recently-boiled water, at the mean temperature, absorb in cubic inches:

| | |
|---|---|
| Sulphuretted hydrogen | 100 |
| Carbonic acid gas | 100 |
| Nitrous oxide | 100 |
| Olefiant gas | 12·5 |
| Oxygen | 3·7 |
| Carbonic oxide | 1·56 |
| Nitrogen | 1·56 |
| Hydrogen | 1·56 |

Rain-water contains 3·5 per cent. of air, and 1 per cent. of carbonic acid gas. Snow-water, fresh, is free from air.

Spring-water is purest, which rises through sand or gravel near the surface. It usually contains some common salt.

Well-water contains earthy salts, as sulphate of lime, which render it hard, and not solvable of soap, for the alkali of the soap unites with the acid of the salts; and then the oil of the soap and the earths combine, and form the light matter which curdles on the surface. It is softened by boiling, and then infusing some carbonate of soda, or potash.

Below 45°, water is an astringent; at 60° a diluent; and above 60°, it relaxes. As an antibilious medicine, taken in the morning, it should be from 70° to 90°.

Under 70°, water is cold to the skin, and the bath is cold under 80°.

From 86° to 100°, the bath is warm. The bath-waters are 110°, 112°, and 114°.

Distillation is the remedy for all its impurities.

Water dissolves definite quantities of most acids, alkalies, and salts. When their atoms have filled its pores, it is saturated. The action is equal and indifferent. If the water is not stirred, the diffusion may be very unequal. They spread because the atoms of the water has pores and motion, and is subject to pressure. When water is frozen, they do not spread. When the atoms of the water unite and fix in the foreign body, this is called an *hydrate*, or crystal of the acid.

The terms *hard* and *soft*, as applied to *water*, are obviously relative; but water, which contains as much as 5 grains in the pint of saline matter, is generally regarded as too hard for many economical and manufacturing processes.

The *hardness* of river and shallow well-water depends upon their containing calcareous salts with carbonate and sulphate of lime, 1 grain of the latter, contained in 2000 grains of soft water, being sufficient to convert it into the hardest water that is commonly met with. Hard water is also subject to become putrid, on account of the vegetable or animal matter which it contains, and generally turbid from the suspension of earthy impurity; and, when drunk, it is flat, from the absence of air.

Well-diggers use a solution of soap to try the quality of the water obtained at different depths. A solution of soap in spirit of wine, if dropped into distilled water, leaves no precipitate; but if the water contain sulphate of lime, it will occasion a white flocculent adhesive precipitate. Some of the springs about London give almost a saturated solution of the sulphate of lime, and such water is very harsh and disagreeable to the taste, and very unfit for washing, or for pharmaceutical or manufacturing processes.

Water may be preserved by dissolving lime in it, and by, when to be used, separating the lime, by adding carbonate of magnesia, or passing a current of carbonic acid gas throughout. It may also be preserved by keeping it in casks, charred in the inside, or in iron tanks. Foul water may be purified by filtering it through porous stones, or alternate layers of gravel and sand, or sand and charcoal. Muddy water may be rendered clear and bright by adding an ounce of alum to 5 or 6 gallons. Putrid water is restored by shaking it with magnesia, or with black oxide of manganese. Thames water may be restored by racking it off, and exposing it to the atmosphere. Hard water, from carbonate of lime, may be softened by brisk boiling; or from sulphate of lime, by the addition of carbonate of soda, or potash, the day before wanted; also by exposing it, for two or three days, in shallow tanks, to the air.

Water, or its constituents, combine with many bodies, forming crystals, powders, and jellies, with the general name of hydrates. In the connection with acids, the hydrates are crystals of the acid, and the water, combined, is called the water of crystallization. With alkaline bases, the water, being decomposed, forms powder.

Water may also be preserved by impregnation, while cold with lime, and then adding some carbonate of magnesia, to neutralize the lime.

The fragrant shrub bog-myrtle, left to steep in pure water, will preserve it sweet and incorruptible for any length of time.

Tests to be added, in a few drops of each, to an ounce or two of water. 1. A solution of nitrate of barytes produces a turbid appearance from the presence of any sulphate or carbonate, and the turbid appearance of it arising from the latter is removed on adding a drop or two of pure nitric acid. 2. A solution of nitrate of silver gives a bluish precipitate from the presence of any muriate; and, if this test is applied after the previous application of pure nitrate of barytes, it is more certain, as any precipitation from the presence of a sulphate or carbonate is removed. 3. A solution of acetate of lead causes a turbid appearance, if sulphates or carbonates are present; while it produces a less marked effect from the presence of muriates. 4. A solution of oxalate of ammonia detects lime by precipitation; and a solution of soap in alcohol indicates, by the degree of turbid appearance it produces, the predominance of sulphate of lime, or the degree of hardness, as it is called. 5. If a solution of phosphate of soda produce a milkiness after a previous addition of a similar quantity of carbonate of ammonia, magnesia is present. 6. The presence of free carbonic acid is detected by a slight milkiness being produced by the addition of an equal portion of lime-water to the water, and with still more delicacy by super-acetate of lead. It is also discovered in the air expelled by boiling, which, on being agitated with lime-water, affords a milky precipitate.

Vapour-baths are from 100° to 130°.

Water may be decomposed, by means of heat, in the following way:—Take a gun-barrel, the breech of which has been removed, and fill it with iron-wire coiled up. Place it across a common chafing-dish, and connect to one end of it a small glass retort, containing some water: and to the other a bent tube, opening under the shelf of the water-bath. Heat the barrel red-hot, by means of charcoal, and apply a lamp under the retort. The steam of water, in passing over the red-hot iron, will be decomposed, the oxygen will unite with the iron, and the hydrogen may be collected in the form of gas.

If this experiment be made very carefully, by placing the iron-wire, previously weighed, in a glass, or very compact earthen tube, instead of the gun-barrel, the weight which the iron will have acquired, added to the weight of the volume of gas produced, will be found exactly to make up the weight of the water decomposed; and they will be, to one another, in the proportion of eight to one.

Water boils at 191° on Etna, at 11,332 feet.

With heat, water is decomposed by zinc, tin, iron, antimony, and phosphuret of sulphur.

*River-water*, which passes over clay, imbibes earthy salts, and also vegetable and animal remains. But when it passes over pebbles, it is often as soft as rain-water.

*Mineral-waters* are *acidulous*; containing carbonic-acid gas, with carbonates of soda, magnesia, lime, and iron, with common salt. *Chalybeate*, with carbonate or sulphate of iron, turning black with tincture of galls. *Sulphureous*, from sulphuretted hydrogen gas, and occasionally with lime. *Saline*-waters contain salts of lime, muriates of soda and magnesia, sulphate of magnesia, and carbonate of soda, and other alkaline earths.

Sea-water contains 22 in 1000 of salt, 4·2 of muriate of magnesia, and 3·3 of sulphate of soda. It is salter as deeper.

The carbonic-acid, in 1000 grains of Pyrmont water, is 2·2 cubic inches; in seltzer 1·5. In others, less than 1; and in Bristol, the highest in England, but 0·06. The highest of any salt is 6 grains in 1000, of muriate of soda in Harrowgate, and 2·6 sulphate of soda in Carlsbad; 8·6 carbonate of lime in seltzer, and 25 sulphate of magnesia in seidlitz. The rest are low fractions of units, proving that they operate chiefly as diluents, and by change of air, agreeable society, &c. &c.

The foreign ingredients, in mineral-water, is determined by multiplying the difference of specific gravity by 1·4. Thus, if the water is 1066, the difference is 66, which, by 1·4, is $66 \times 1{\cdot}4 = 92{\cdot}4$, for the gases and salts.

To ascertain their saline contents, considering the specific gravity of common water as 1000, subtract it from the specific gravity of the mineral-water, and multiply by 1·4. The product is very nearly the saline contents of the mineral-water.

*Distilled-waters* are such waters as are impregnated with the essential oils of herbs; and they may be prepared in small quantities by mingling the essences with water, or by making the essence itself with the essential oil and alcohol, or by triturating an ounce of the oil with ten ounces of sugar, or magnesia.

*Sea-water*, as analysed by Dr. Murray, contains, in a pint, lime 2·9 grains, magnesia 14·8, soda 96·3, sulphuric acid 14·4, muriatic acid 97·7, in all, 226·1 grains; which, in elementary classification, is, muriate of soda or salt 159·3, muriate of magnesia 35·5, muriate of lime 5·7, sulphate of soda 25·6; 226·1 grains as before. It has since been found to contain some potash and ammonia, besides its animal and vegetable impregnations. Every pint contains ½ an ounce of purgative salts.

Halley calculated that the current of the Thames, in one year, carries through Kingston-bridge 250 thousand millions of cubic feet, and that the Thames drains 5000 square miles; therefore, 50 millions of cubic feet flow from every mile of the drained surface.

Water is not to be simply regarded as a neutral fluid, condensing hydrogen with oxygen, but as a physical agent, in falling, with force, from higher to lower levels, and as the means of balancing the earth in its varied distances as a planet, from the sun, and thereby giving a new face to both hemispheres, in periods of 20,130 years, which may be likened to a day of Nature.

Its fluidity and universality render it also an agent of communication and of power, in mills, engines, &c.

*Bran-water*, used by dyers, is made by heating a peck of bran in 2 gallons of water, dissolving ½ a pound of alum in it, and stirring occasionally.

*Water-proof Liquid.*—In 6 oz. of oil of turpentine dissolve (by gentle heat,) 3 drs. of Indian-rubber, and then mix with 8 oz. of linseed-oil.

WAX, is a vegetable and animal production. It is formed in the resin of the wax-palm of South America, in the *Myrica Cerifera*, or wax-tree of the Mississippi and Ohio; and in a Chinese Gourd, all most worthy of cultivation, but neglected by the inhabitants of the countries. Bees-wax is a secretion in four cavities, called the wax-pockets of the insect, and applied by it to build its comb, cells, &c. For use, it is purified and bleached. The yellow is melted with some water, and then passed through an aperture to a vessel beneath. It is then passed through a cullender, so as to fall on a cylinder which turns into cold-water, and reduces it to fine threads. These are watered in the sun until half bleached, rolled again into a mass, and in three or four weeks treated as before, after which it is cast in plates for sale. Its specific gravity is then about 9, and it melts at 155. With fixed oils it becomes cerates. It is 81·6 carbon, 14 hydrogen, and 4·4 oxygen. In medicine it is used only in dysentery with oil. In the arts it is used variously, and especially for candles, though very expensive.

WAX-MYRTLE, OR BAYBERRY, (*myrica cerifera;*) a low, spreading shrub. The berries are as large as a pepper-corn, and, when ripe, are covered with a whitish-green wax, which is collected by boiling them: the fat then melts out, floats at the top of the water, and may be skimmed off. When congealed, it looks like tallow or wax, but has a dirty-green colour. It is therefore melted again, and refined, by which means it acquires a transparent green colour. It is dearer than common tallow, but cheaper than wax. This wax is used for a variety of purposes, but chiefly for making candles, which burn slowly and with but little smoke, emit an agreeable odour, and never melt and run down at the sides, like tallow and spermaceti; but, as they do not give a strong light during cold weather, it is usual to add a portion of tallow. A fine-scented and excellent soap, and also sealing-wax, are made from these berries.

*Red Sealing-wax.*—Mix 3 oz. of olive-oil with equal quantity of turpentine, to which add 4 oz. of vermilion, and 2 lbs. of gum-lac. Roll in cakes, and with a rag polish till cold. *Or*, mix yellow rosin 6 lbs., shell-lac 2 lbs.; Venice turpentine 2 lbs.; and red chalk (bole) 8 oz.

*Black Sealing-wax* is the coarsest lac and turpentine in the above proportions, with lamp-black instead of bole.

*Marbled Sealing-wax* is the mixture of the coloured liquids while in a melted state.

WEALTH, a personal relation of legal property, or of the convertible representation of property in currency. Wealth of Nations, in currency, is a solecism; for, if wisely governed, and there is a fair distribution of products, and an equal population, one nation is as rich as another, whatever may be the arithmetic of the currency. If a hundred thousand pounds of gold serve for the measure of value in one, and a million in the other, and the distribution of real wealth is fair, the coefficient of money makes no difference; or, at least, less to the first nation than the second, since increases of currency serve, in a much higher ratio than amount, to facilitate personal abstractions, or accumulations. Hence it is, that, in England, money-dealing swells the coffers of some, and leaves the mass of the community in want and pauperism. For whatever be the amount, if constant, the accumulations of one must be taken from others, while the excess of accumulators enable them to raise prices, and thereby give more mischievous effect to privation.

The only real wealth of nations is industry, and its protection, by good laws, of easy access to every class. The spade, the plough, the reaping-hook, the spinning-wheel, the loom, the hammer, and the forge, actively employed, with such improvements as may not delude by false estimates, are the true wealth of nations. Wise policy always discourages accumulators, and seeks to spread as extensive a mediocrity as possible. The facilities afforded to great accumulations is, at this time, the curse of British society.

WEAVING, is attributed to the Egyptians; but it has received great improvements in modern times, and is different, according to the nature of the texture to be produced. The art of weaving, by the power of steam or water, is now successfully carried into operation; and such is the improved state of the process, that one girl attends two looms. This mode of weaving has resulted from the process for dressing the web before it is put into the loom. This renders the stoppage of the work, from time to time, unnecessary.

As the threads which constitute the warp are liable to much friction in the process of weaving, they are subjected to an operation called *dressing*, the object of which is to increase their strength and smoothness, by agglutinating their fibres together. To this end they are pressed between rollers, impregnated with mucilage made of starch, or some gelatinous material, and immediately afterwards brought in contact with brushes, which pass repeatedly over them, so as to lay down the fibres in one direction, and remove the superfluous mucilage from them. They are then dried by a series of revolving fans, or by steam cylinders, and are ready for the loom.

Woven textures derive their strength from the same force of lateral adhesion, which retains the twisted fibres of each thread in their situations. The manner in which these textures are formed is readily understood. On inspecting a piece of plain cloth, it is found to consist of two distinct sets of threads, running perpendicularly to each other. Of these, the *longitudinal* threads constitute the *warp*, while the *transverse* threads are called the *weft* or *woof*, and consist of a single thread, passing backwards and forwards.

In weaving with the common loom, the warp is wound upon a cylindrical beam or roller. From this the thread passes through a *harness*, composed of moveable parts, called the *heddles*, of which there are two or more, consisting of a series of vertical strings, connected to frames, and having *loops*, through which the *warp* passes.

When the heddles consist of more than one set of strings, the sets are called *leares*. Each of these heddles receives its portion of the alternate threads of the warp, so that, when they are moved reciprocally up and down, the relative position of the alternate threads of the warp is reversed.

Each time that the warp is opened by the separating of its alternate threads, a *shuttle*, containing the woof, is thrown across it, and the thread or woof is immediately driven into its place by a frame called a *lay*, furnished with thin reeds or wires, placed among the warp, like the teeth of a comb. The woven piece, as fast as it is completed, is wound up on a second beam, opposite to the first.

Power-looms, driven by water or steam, are now universally introduced into manufactories of cotton and wool. The motions of the loom are produced, in some looms, by the agency of cranks, and in others by cams or wipers, acting upon weights or springs.

In plain weaving, every thread of the warp crosses at every thread of the woof, and *vice versa*. But, in articles which are *twilled*, or *tweeled*, this is not the case: for, in this manufacture, only the third, fourth, fifth, sixth, &c. threads cross each other to form the texture. In the coarsest kinds, every third thread is crossed; but, in finer fabrics, the intervals are less frequent, and, in some very fine twilled silks, the crossing does not take place till the sixteenth interval.

A loom, invented in the United States, has been applied to the weaving of twilled goods by water-power. Jeans, dimities, serges, &c. are specimens.

In double weaving, the fabric is composed of two webs, each of which consists of a separate warp, and a separate woof. The two, however, are interwoven at intervals, so as to produce various figures. The junction of the two webs is formed by passing them at intervals, through each other, so that each particular part of both is sometimes above and sometimes below. When different colours are employed, as in carpeting, the figure is the same on both sides, but the colour is reversed. The weaving of double cloths is commonly performed by a complicated machine, called a *draw-loom*, in which the weaver, aided by an assistant, or by machinery, has the command of each particular thread by its number. He works by a pattern, in which the figure before him is traced in squares, agreeably to which the threads to be moved are selected and raised before each insertion of the woof. Kidderminster carpets and Marseilles quilts are specimens.

*Cross Weaving.*—This method is used to produce the lightest fabrics, as gauze, netting, catgut, &c. In the kinds of weaving which have been previously described, the threads of the warp always remain parallel to each other, or without crossing. But, in gauze-weaving, the two threads of warp which pass between the same splits of the reed, are crossed over each other, and partially twisted, like a cord, at every stroke of the loom. They are, however, twisted to the right and left alternately, and each shot, or insertion of the woof, preserves the twist which the warp has received. A great variety of fanciful textures are produced by variations.—*Bigelow.*

WEEVILS.—Wash the floor and sides of the granary with a mixture of urine and water, before the corn is stored up, and this washing is to be repeated several times. The walls and floors of the granary should be well swept between each operation.

WEIGHT OF BODIES, is the motion, or force, with which bodies are made to fall towards the centre of the earth. This used to be ascribed to the word *gravitation*, a translation of the word *weight*, or heaviness, which was as much as saying, that bodies fall *because they are heavy.* But this wordy philosophy has now generally yielded to the Author's original theory, that central force is a necessary result of the simultaneous two-fold motions of the earth, or any planet, the orbit motions (direct of the mass), and the rotatory (deflective of the parts), so that the direct and deflective force carries every part of the mass, in their diagonals (the radii), towards the common centre of both motions, and of the mass. The mode of verifying this principle, by calculation, is various; but, taken in perpendicular deflection, the forces, in a second, are as 101·1 to 1; on either side the line of the centre in the orbit, or in circular rotation, in a second, as 64·35 to 1. The first, divided by 6·28318, the whole circle, gives 16·08725 for the fall; and the latter, by the square of the diameter, or by the ratio of the whole sphere to the area of the equator, gives 16·08725, the fall in a second exactly. The computation, by a resolution of two forces in the diagonal, agrees. Of course, the fall is accelerated as the *surfaces* rotate, or as the squares of the times, since the times correspond with their equable surfaces. Thus, for half a second, it is one-fourth; and, for two seconds, four times, 16·08725. Then the fall and rotation being given, by observation, we have, in their multiple, the orbit and distance of the sun. Such is the simplicity of nature and truth.

The mean perpendicular deflection, by the rotation, is 971 feet per second, which, in the circle 971 × 6·283 = 6096 feet, and 98063 by 6096 is 16·08 feet of fall per second in the diagonal radius. But, if taken in the circle, it is 1524 nearly per second, which, by the four radii, is also 6096, with the same result. Then, for different latitudes, it is as the square of the sine and co-sine, which is every where equal to the square of the radius; for, in latitudes, the force is decomposed into two forces,—the deflective as the co-sine, and a perpendicular force, directed to the plane of the equator, as the sine.

WEIGHTS AND MEASURES, are so apportioned in England, by law, that a yard is 36 inches, of which a seconds pendulum is 39·139 inches.

A lb., avoirdupois, is equal to 1 cubic foot, or 1728 cubic inches of distilled water, at $56\frac{1}{2}°$.

A lb., troy, is the $\frac{5760}{7000}$th of the lb. avoirdupois, that is, 175 lbs. troy are 144 lbs. avoirdupois.

A gallon is 10 lbs. avoirdupois of pure water, or 277·274 cubic inches; a quart 69·3185 cubic inches, and a pint 23·05925 cubic inches.

In the old French weights, a Paris lb. is equal to 7561 English grains, and is divided into 9216 Paris grains.

Hence, the old Paris lb. is, to the English avoirdupois, as 7561 to 7000.

And the French grain is to the English as $\frac{1}{9216}$ of $\frac{7561}{7000}$, as 7000 to 8532·5, or 1 to 1·2189.

The old French foot and inch is to the English foot and inch as 1·065977 to 1.

One lb. avoirdupois, or 7000 grains English, is 453·25 grains, and 1 gallon English is 3·78515 litres.

In larger weights, a cwt. is 112 lbs., and a ton 20 cwt., or 2240 lbs.

A pound avoirdupois is 16 oz. of 16 drachms each, or 7000 grains. The lb. used by apothecaries is 5760 of the same grains, and is divided into 12 oz. of 8 drms., and these into 3 scruples. A cubic-inch of distilled water, at 60°, is 252·506 grains, and 1 grain is 0·00396 of a cubic inch. 1 lb. avoirdupois is 1·215277 lbs. troy, or as 7000 to 5760.

The French standard *gramme* is 15·444 grains, or rather more than the fourth of our apothecary's drachm, or 1·8th nearly our avoirdupois drachm.

The English grain is to the French gramme as 1 to 0·06477.

The English lb. avoirdupois to the French kilogramme as 1 to 0·4534148.

The cwt. is 50·78246 kilogrammes.

A quintal is 100 kilogrammes, or $220\frac{1}{2}$ lbs. 1000 grammes are 1 kilogramme.

The ancient mina varied from 5 to 7 grains English.

The talent was 56 lbs.

WHEAT succeeds best when treated as a biennial, though it does not remain above one year in the ground. Provided the soil be well prepared and dry, and the grain sown in time, the plants do not suffer from the greatest colds, especially if the ground be covered with snow.

Animal substances are the best manure for wheat, as containing much gluten, a substance found in a greater proportion in this grain than in any other; and next in importance is lime, as tending to the same effect by chemical combinations.

Wheat yields a greater proportion of flour than any other grain, and is also more nutritive. Gluten is so essential an ingredient in bread, that fermentation cannot go on without it; hence its inferiority in wet seasons, and when the wheat is blighted or ill-ripened; and hence the advantage of having a stock of old grain.

Wheat-starch is made by steeping it, and afterwards beating it in hempen bags. The mucilage, being thus mixed with the water, produces the acetous fermentation, and the weak acid thus formed renders the mucilage white.—After settling, the precipitate is repeatedly washed, and then put in square cakes for drying.

The straw of wheat, from dry chalky lands, is manufactured into hats.

Wheat, besides its internal diseases of smut and rust, has four fatal enemies in slugs, grubs, wire-worms, and wheat-flies, against neither of which is there yet any effectual remedy, but winter and early crops suffer less than spring. By one or the other, a million of quarters are annually destroyed by the three first in the young plant, and by the other in the ear. The slugs destroy the root by day and the blade by night. The grubs are not equally numerous every year, but when abundant they utterly destroy the crops. The wire-worm devours, in England alone, 60,000 acres of wheat annually. But the more fatal enemy is the wheat-fly, whose object it is to deposit their eggs in the seed. Their numbers surpass belief, and they render many whole tracts not worth cutting down. The only remedy proposed is the planting of elder in and near the crops, its effluvia being very noxious to the insects. Spring-wheat suffers more than early.

Smut, in wheat, is prevented by immersing the seed in a solution of blue vitriol, at the rate of an oz. of the vitriol to nearly a gallon of water. The light seeds are to be skimmed off, and the others washed in water and dried. It is the seeds of a fungus. Or 5 lbs. of vitriol may be dissolved in hot-water, and then as much cold as covers three bushels of wheat. The liquid is then run off through a sieve, the light-grain skimmed off, and shook till dry. For other quantities of three bushels another lb. of the sulphate is added to the liquor, and more water added.

Every bushel of wheat has three trusses of straw, of 36 lbs. each, or, at 24 bushels to the acre, is 72 trusses or 2,592 lbs. The stubble, &c. makes 3,000 lbs. Then 24 bushels, at 60 lbs., are 1,440 lbs. making 4,440 lbs. for the crop per acre. Rye is 4,000 lbs. of straw, oats 3,000 lbs. and barley 1,500 lbs.

Rust in wheat is ascribed to excess of manure, and is avoided either by throwing salt over the field, or taking a previous crop of cole-seed, or tares.

WHEELS.—In complex wheel-work, the power is applied to the circumference of the first wheel, which transmits its effect to the circumference of the second wheel, which again transfers the effect to the circumference of the second axle, which acts upon the circumference of the third wheel, and this, in the same way, transmits the effect to the circumference of the third axle, and thus the transmission of the force is continued until it has arrived at the circumference of the last axle, to which the weight or resistance is applied.

In light-work, where the pressure on the machinery is not very considerable, the wheels and axles are allowed to work by the friction of their surfaces, which is increased by cutting the wood so that the grains of the surfaces in contact shall run in opposite directions; also by gluing upon the surfaces of the wheels and axles buffed leather.

There are other ways of transmitting the force of each axle to the circumference of the succeeding wheel. A very common method is, by ropes, straps, bands, or belts, round the circumference of the wheel and axle, which act upon each other. The action is in this manner transmitted by the tension of the rope or strap, and rendered effective by friction with the circumferences on which it is rolled. Wheels and axles, connected in this manner, are called *band-wheels*. When the wheel and axle from which it receives motion are intended to revolve in the same direction, the band is not crossed, but simply passed round them in the shortest manner; but, when the wheel is to revolve in a direction contrary to the revolution of the axle, the strap is crossed between them. This latter method of applying the strap has the advantage of having more surface to act upon, and, therefore, having more friction. The most usual way of transmitting the action of the axles to the succeeding wheels, is by means of teeth or cogs, raised on their surfaces. When this is the case, the cogs on the wheels are generally called *teeth*, and those on the surface of the axle *leaves*. The axle itself, in this case, is called a *pinion*. The connexion of one toothed-wheel with another, in this manner, is called *gear* or *gearing*.

The teeth of the wheel, instead of working in the leaves of a pinion, are sometimes made to act upon a form of wheel called a *lanthern*, with cylindrical teeth or bars, called *trundles* or *spindles*.

Wheels are denominated *spur*, *crown*, or *bevel-gear*, according to the direction or position of the teeth. If the teeth are perpendicular to the axis of the wheel, and in the direction of its radii, it is called a *spur-wheel.* If the teeth are parallel to the axis of the wheel, and therefore perpendicular to its plane, it is called a *crown-wheel.*—Two spur-wheels, or a spur-wheel and pinion which work in one another, are always in the same plane, and have their axes parallel; but, when a spur and a crown-wheel are in connexion, their planes and axles are at right angles.

By this means, therefore, rotatory motion may be transfered from a horizontal to a vertical plane, or *vice versa.* When the teeth are oblique to the plane or axis-wheel, it is called a *bevelled-wheel.* In this case, the surfaces on which the teeth are raised are parts of the surfaces of two cones. The use of the bevelled wheels is to produce a rotatory motion round one axis, by means of a rotatory motion round another which is oblique to it; and, provided that the two axes are in the same plane, this may always be accomplished by two bevelled wheels.

Wheels consist of the *nave* or stock, in the centre, the *spokes* which are radii, and the *ring*, which is the periphery of the wheel. When a wheel is to be made, the workman adapts moulds to its exact diameter. Twelve spokes are commonly assigned to the larger wheels of carriages, and ten to the smaller ones. The working and finishing of the several fellies, to form the periphery of a wheel, consists, after it has been roughly chopped to the pattern, in forming its inside-edge somewhat rounding, and getting its outside edge perfectly circular, and to form such an acute angle, that, when the wheel is adapted to the axle-tree, it shall stand square and solid under the body of the carriage.

The strength of a wheel depends greatly on the attention paid to the arrangement and framing of the spokes; in common wheels they are framed regularly and equally all round the thickest part of the nave, the tenons of the spokes being so bevelled as to stand, with reference to the horizontal position of the nave, about three inches out of the perpendicular: this is done to produce what is called dishing. But, for wheels of strength, such as the wheels of mail-coaches, the framing of the spokes consists in getting every other one perpendicular to the nave. Hence the mortises to receive them in it are not made in a parallel line round it, but stand, in two different parallels, one without the other, by which greater solidity is given to the nave, and an immense addition of strength.

The boxing of a wheel, and adapting the axle-tree, is done usually by the coach or tire-smith. The box of a wheel is a hollow conical tube of iron, furnished on its outside with two or three square projections, which have the effect of giving it a key when mortised through the nave of the wheel. Patent boxes are of a different construction, and owe their safety to four bolts, which pass completely through the nave of the wheel, having a square shoulder on the back of the nave, with screws and nuts on its front. The box to such a wheel is made, as are the other boxes above described, except being completely closed at its outer-end, with a solid and broad cap of iron, of sufficient diameter to enclose completely the end of the nave. The axle-tree, too, is formed to fill the box, and press up close to this iron cap.

High wheels are, in bad roads, much preferable to low ones, except where the shape of any inequality of the road permits the low wheel to *roll*, while the larger wheel can bear only on the edges of the hole over which it is to pass. But the increased expense and weight of very large wheels put a limit to their size, beyond which no experienced mechanic would pass. For, although the mechanical power of a wheel in surmounting a given obstacle constantly increases with the size of the wheel, it does not increase *directly* in proportion to its height. It increases but little more than in proportion to *the square roots* of the diameter of the wheel; so that if a wheel pass over an obstacle with a given power, though it may be made to pass over the same obstacle with half that power by increasing the diameter of the wheel, it is not to be expected that this can be done by making the wheel twice as large: for, to effect this purpose, a wheel of *four times* the former diameter must be employed.

Mr. Edgeworth shewed that practice agrees with theory. A wheel of seven inches diameter, loaded with twenty-pounds, required eight pounds to draw it over an obstacle of one-quarter of an inch high, whereas, when a wheel of twenty-eight inches high was employed, four pounds drew the same load over the same obstacle. And, when the line of draught was horizontal, the larger wheel required four pounds four ounces, the smaller nine pounds.

It appears, that the higher the wheels the more advantageous is the draught;

but, in fact, the expense, the strength, and the weight of wheels must be taken into account, when they are applied to carriages; and experience has determined, that the best height of wheels is from four feet six inches to five feet, for coaches and carriages that move swiftly; and that, for heavy carriages, wheels seldom are found useful beyond the diameter of six feet.

As narrow wheels always sink into the ground, especially when the heaviest part of the load lies upon them, they must be considered as going constantly up-hill, even on level ground. And their sides must sustain a great deal of friction by rubbing against the ruts made by others. But both these inconveniences are avoided by broad wheels; which, instead of cutting and ploughing up the roads, roll them smooth and harden them, as experience testifies in places where they have been used, especially either on wettish or sandy ground. The fore-wheels of all carriages ought to be so high as to have their axles even with the breasts of the horses, which would not only give the horses a fair draught, but likewise cause the machine to be drawn by a less degree of power.

When the spokes are inclined to the nave, the wheels are said to be concave, or dishing.—But it is allowed, on all hands, that perpendicular spokes are preferable on level ground. The inclination of the spokes, therefore, which may render concave wheels advantageous in rugged and unequal roads, renders them disadvantageous when the roads are in good order.

M. Camus shewed that the line of traction should be a horizontal line, or rather, that it should always be *parallel to the ground on which the carriage is moving*, both because the horse can exert his greatest strength in this direction, and because the line of draught, being perpendicular to the vertical spoke of the wheel, acts with the greatest possible leverage. M. Deparcieux shews, in the most satisfactory manner, that animals draw by their weight, joined to the force of their muscles. In four-footed animals, the hind-feet are the fulcrum of the lever by which their weight acts against the load, and when the animal pulls hard, it depresses its chest, and thus increases the lever of its weight, and diminishes the lever by which the load resists its efforts.

Though there cannot be any doubt but that carts must vary in their forms, sizes, and modes of construction, according to the nature and situation of the roads, and many other local circumstances; yet, for the purposes of farming, especially in field-work, those of single-horse and two-horse kind are in general the most advantageous, convenient, and useful. Lord Robert Seymour says, that "the advantages of single-horse carts are universally admitted, wherever they have been attentively compared with carriages of any other description. By his own observation he is led to think that a horse, when he acts singly, will do half as much more work as when he acts in conjunction with another; that is to say, that two horses will, separately, do as much work as three conjunctively. Mr. Young is decidely of the same opinion, which he clearly shews to be founded in truth, by entering into a variety of discussions in respect to the points in which they are preferable to tumbrils or waggons. In the northern districts they usually draw in these carts from twelve to twenty-four hundred weight, and, where the roads are good, occasionally thirty, with ease and facility.

Wheels, in machinery, require that the product of the power at the pitch-line of the wheel in lbs. and the length of the teeth should be equal to the product of the square of the thickness of the teeth, the breadth of the teeth, and the number 212. Allowance should then be made for wear.

In the arms, the resistance at the end of the arm in lbs. into the cube of its length is equal to 2656, by the number of arms (the deflection,) and the breadth and cube of the depth of the arms.

Again, the product of the breadth of the teeth, by the square of their thickness, is equal to their length by the horse-power, the velocity being 136 feet per minute.

The breadth of teeth should be 2·5 times their pitch, and the pitch is 2·1 times the thickness. The length is 1·2 times the thickness, when the pitch is 4·2, the thickness is 2, the breadth 8, the length 2·4.—*Brunton.*

The wheel on the axle of the first mover is usually called the *spur*; and the wheel turned by a spur, and which sets the machinery in motion, is called the *trundle.*

The fly-wheel is a very important wheel in all machinery, to receive the power, and distribute it equally to the works, and hence often called the balance-wheel; but, when there is a superfluity of power, at certain times it is used as a condenser or concentrator of power, with weights in its circumference, so that it would continue the action for some time if the prime-mover stopt. In steam-engines the regulators are called governors.

In two-toothed wheels, the greater is the wheel the less the pinion, and, when spokes or staves are used, the pinion is a trundle. The circles which two wheels form are called the pitch-lines, and they should have equal and uniform velocities.

Templets, or pattern-teeth for wheels, ought to be epicycloids or parts of such a curve as any particular point in a coach-wheel describes, while the wheel goes round and forward, for that is the angle or direct plane of propulsion in circular motion.

The distance from the centre of a wheel to the extremity of its teeth, or leaves, is the true radius of its force: and the teeth constitute the primitive radii.

The working power of an over-shot water-wheel is only two-thirds the multiple of the weight of water by the height of the fall, owing to the centrifugal rotative force, and the waste in the descent of the buckets.

In an under-shot wheel the power must be two two-fifths more, and in a breast-wheel $1\frac{3}{4}$ more.

WHISKEY, is the product of barley and oats, by infusion, fermentation, and distillation, in the proportions of 1 malt, 5, 6, or 7 of barley, and varied proportions of oats, to 12 gallons of water, at 150°, for every bushel of grain. This is mashed for two hours, and the heat maintained by water at 180° or 190°.

After settling, a portion is drawn off, and more water added to the grains, and mashed, settled, and drawn off. Rapid cooling follows to 65° or 70°, producing wort at 1·06. Yeast is added from time to time, and then fermentation raised to 80°, and kept up for 12 or 14 days, till the sp. gr. has fallen nearly to that of water. Distillation follows, and produces low wines at 0·975, or 20 per cent. of pure alcohol. Redistillation reduces it from 0·909 the strongest, to 0·934, or, per excise, 0·91917. Such is the spirit which rectifiers, by flavouring, convert into liquors for the market.

WHITE ARSENIC.—*See* Arsenic.

WHITE OINTMENT.—Mix 3 oz. of cerus, 2 oz. of white-wax, and 9 oz. of rose-oil.

WHITING, is made from common chalk with alum-water, and then washed in waters.

WHITWORTH RED BOTTLE.—(*Taylor's, Whittle's, and Oldfield Lane, Doctor's, Red Bottle.*) Take 1 lb. of alcohol, 1 scr. of cochineal, 1 oz. of camphor, and 1 dr. of oil of thyme, and of rosemary.

WINE.—The wines of France are made from vineyards, which cover from 4 to 5 millions of acres, and they produce from 20 to 30 millions sterling. Wheat, another great article of produce, occupies about 7 millions of acres, and yields about 40 millions.

The Red Port, drank in England, is chiefly made from grapes grown in the province of Entre-Douro e Minho, the most fertile district in Portugal; it also exports oranges and lemons. The *tannin* principle, in the skins of Portugal grapes, gives Port-wine its astringent character.

Colour of wine is also derived from the skin; flavour in Claret and Burgundy results from fermentation.

When the sugar and the extractive matter have neutralized each other, it is *dry wine*; but, if the sugar prevails, it is sweet wine; if the other, it ferments and turns to vinegar, and frequent racking is adopted, and treatment with sulphuric acid.

Unripe grapes make fermenting wines, and have most tartaric acid. 54° is the best heat for wine-making. The effervescence of Champagne is the separation of the carbonic acid from the alcohol.

Age improves most wines, by completely incorporating the sugar.

When sweet wines are wanted, the leaven is skimmed as it rises, and the fermentation runs off in the cask. In dry wines the yeast is retained, and it is stirred and rolled, to prolong the fermentation. If brisk wines, the leaven must be increased, and the fermentation be made in close vessels.

When wine has attained a sufficient maturity, it is freed from the lees, by being *racked*, as it is termed, into a clean cask: and, in order to prevent a renewal of the fermentation, it is subjected to the operation of sulphuring. This process is generally performed by means of sulphur-matches, applied to the cask into which the wine is to be racked, and, should the fermentation still continue, must be renewed as often as is necessary. Sometimes must, strongly impregnated with sulphurous acid gas, is added to the wine, and answers the same purpose. After sulphuring, the greater proportion of wines require to be further clarified, or fined, before they attain a due brightness. The substances in general use are, isinglass and the white of eggs; but, as these are of a putrescent nature, gum-arabic has been used instead of them. In Spain, the white wines are sometimes clarified with fullers'-earth: powdered marble, gypsum, heated flints, beech-wood chips, sand, &c. are also used.

Wines are of four kinds, the effervescing, as Champagne; the sweet and strong, as Malmesley, Tokay, and Frontignac; the delicate, as Hermitage, Claret, Burgundy, Moselle, &c.; and the dry and strong, as Port, Sherry, and Madeira.

Wines vary in quality, not only with regard to the kind of grapes, and the soil and climate in which they grow, but in the mode and care of making. In some districts the bunches, stalks, and all, ripe and unripe, are pressed; in other places the ripe and sound are separated, and the stalks rejected; and in others they are kept till they almost acquire the nature of raisins.

The climate is from latitude 50° or 51° to the tropics.

The Frontignac, Fontainbleau, and black Hamburgh Grapes, are the finest eating: but the Levant yields single bunches of 30 or 40 lbs. They are antiseptic, laxative, and diuretic.

The juice, or *must*, contains water, sugar, mucilage, albumen, gluten, tannin, potash, lime, magnesia, soda, and some acids.

The fermentation depends on the saccharine mucus, and it commences at 70°. Scum arising, and carbonic acid gas being evolved. In a few days, the scum falls to the bottom, and the sweet must has become vinous liquor.

It is then transferred to casks, and when all fermentation has subsided, is bunged up or bottled. In coloured rough-wines, the skins are fermented, but in white wines, whatever the colour of the grape, the skins are removed, and the juice only fermented.

Sour wines are often corrected by oxides of lead; but this poison may be detected by a few drops of prussiate of potash, which precipitates the lead as a white powder.

If wine contain oxide of lead, it may be discovered by transmitting through a portion of it, in a wine-glass, a current of sulphuretted hydrogen gas, which will cause a glistening black precipitate of sulphuret of lead.

Few wines naturally possess much flavour; and the same is true, to a great degree, of colour. It is, therefore, a part of the business of the manufacturer to communicate, artificially, such a flavour and colour as the taste of the customer demands. This result is obtained in various ways, some of which continue a secret. The flavour, however, is often generated by the application of bitter almonds, oak-chips, orris-root, wormwood, rose-water, &c., while colour is produced by the use of dye-woods, logwood, &c., berries, oak-chips, burnt-sugar, iron, &c. Both processes require to be managed with great delicacy and skill.

Wines are red when the black grape, with its skin, has been used, and of more or less yellowish-white colour when the white grape, or even when the black grape, freed of its skin, has been employed.

For the fining of wines, arsenic is sometimes used, and nitrous ether, orris, and bitter-almonds, to confer flavours.

M. François regards tannin as a remedy for *the grease of wine*. Red wines are never subject to the grease. Now, the difference between red and white wine is, that the red always ferments in presence of the husk and seeds of the grape, substances which contain tannin in abundance, while white wine remains in contact with the husk but a very short time. Twenty grains of tannin to a bottle of wine, or $3\frac{1}{2}$ oz. to a hundred bottles, previously well decanted from all sediment, is the proper dose, although, in frequent cases, this dose must be repeated. If any sediment remain in the wine, a much larger dose of tannin becomes necessary.

*To restore Wine becoming Sour.*—Take dry walnuts, in the proportion of one to every gallon of wine, and burn them over a charcoal-fire; when they are well lighted, throw them into the wine; bung up, and in 48 hours the acidity will have been corrected.

Wine, &c. in draught, is kept fresh by pouring a flask of olive-oil upon it.

Dr. Ure thinks, that if tartar was added to the *must* of our British wines, it would much improve them.

The quantity of alcohol at 0·825 per cent. in different wines, has been determined, by Brande, as under:

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|---|---|
| Red Port | 22·96 |
| Sherry | 19·17 |
| Malaga | 18.94 |
| Tent | 13·3 |
| Champagne, White | 13·3 |
| Ditto Red | 11·93 |
| Burgundy | 14·57 |
| Hermitage | 32·2 |
| Frontignac | 12·79 |
| Claret | 15·1 |
| Second ditto | 13·37 |
| Barsac | 13·65 |
| Sauterne | 14·22 |
| Rhenish, White | 10 |
| Ditto, Red | 13·68 |
| Tokay | 9·88 |
| Marsala | 25 9 |
| Etna | 30 |
| Madeira | 21 |
| Teneriffe | 19·79 |
| Cape Madeira | 20·51 |
| Constantia | 14.5 |
| Raisin | 25·12 |
| Currant | 20·55 |
| Gooseberry | 11·84 |
| Elder | 9·87 |
| Cyder | 9·87 |
| Perry | 7·26 |
| Mead | 17·32 |

So that Hermitage and Etna are the strongest wines, Marsala and Raisin next; and Port, Madeira, and Sherry, contain a fifth of alcohol, or nearly a pint of brandy.

*Artificial Port Wine.*—Cider 3 quarts, French brandy 1 quart, gum kino 1 dr.

*Artificial Old Hock.*—Cider 3 quarts,

French brandy 1 quart, alcoholized nitric ether 1 drachm.

*French Currant Wine.*—Eight lbs. of honey are dissolved in 15 gallons of boiling water, to which, when clarified, is added the juice of 8 lbs. of red or white currants. It is then fermented for 24 hours, and 2 lbs. of sugar to every 2 gallons of water are added. The preparation is afterwards clarified with the whites of eggs, and cream of tartar.

*French Gooseberry Wine.*—The fruit is gathered dry, when about half ripe, and then pounded in a mortar. The juice, when properly strained through a canvas bag, is mixed with sugar, in the proportion of 3 lbs. to every 2 gallons of juice. It is then left in a quiet state for 15 days; at the expiration of which it is carefully poured off, and left to ferment for three months when under 15 gallons, and for five months when double. It is then bottled, and soon becomes fit for drinking.

Spirits constitute from 12 to 25 per cent. of wines, and from 2 to 8 per cent. of malt-liquors.

The fermentation of extracts is usually hastened by yeast, crude tartar, or bruised vine-leaves; but this is not necessary for wines, if kept in proper temperature. Malt-liquors are more sluggish. If the fermentation proceeds too far, it may be stopped by drawing off the clear liquor into another vessel, in which some brimstone has been newly burned, or, in red-wine, some nutmeg-powder burnt upon a hot shovel. The sediment left in the former cask may be strained through flannel, or paper, till clear, and added to the other.

*Or*, in case of too rapid fermentation, a part only may be drawn out of the cask, and some rags, dipped in melted brimstone and lighted, may be held within the bung-hole, so as to impregnate the liquor with the fumes, (about 1 oz. brimstone to a hhd.) then return what had been drawn out, and bung close.

*Or*, a small quantity of sulphuric acid may be poured in: *Or*, some black manganese.

If the fermentation has already become sour, further fermentation may be stopped, and some lumps of chalk, or burned oyster-shells added, to neutralize the acid already generated.

If liquors do not become clear, dissolve 1 oz. of isinglass in 2 lbs. of water, strain it, and mix it with part of the liquor; beat it up to a froth, and pour it into a barrel; stir well, and bung it up. Red wines are fined with eggs, about 12 to a pipe, beaten up to a froth, and well stirred in the cask.

When the liquor has acquired a bad flavour, let the fermentation proceed, and convert it into vinegar.

The above are the usual methods, but most persons have peculiar ways; fermentation may be varied to produce a sweet or dry wine; the sweet being less fermented. Brandy destroys the proper flavour, and it is better to increase the strength by increasing the quantity of raisins or sugar. The must ought to be, raisins 6 lbs. or sugar 4 lbs. to the gallon, allowing for that in the fruit; and, in most fruits, especially black currants, it improves the flavour to boil them previous to making the wine.

Bitter almonds are added for a nutty flavour; sweet briar, orris-root, cherry, laurel-water, and elder-flowers, to give the bouquet to high-flavoured wines; alum to render young and meagre red wines bright; Brazil wood, cake of pressed elderberries and bilberries, to render pale faint Port of a rich deep purple colour; oak sawdust, and the husks of filberts, to give astringency; and a tincture of the seeds of raisins to flavour fictitious Port wine. Wine is also coloured with red beet, but is rendered colourless by lime-water. Genuine red wines yield a greenish grey precipitate, with a solution of sugar of lead; but those coloured with bilberries elderberries, or logwood, give deep blue precipitates, and those coloured by Brazil wood, red sanders, and red beet, red precipitates. Gypsum is used to clear cloudy white wines, as also lime; and the size of a walnut of sugar of lead, with a table spoonful of salenixum, is put to 42 gallons of muddy wine to clear it; and hence, as the sugar of lead is decomposed, it is changed into an insoluble sulphate of lead: which Gray says is not so dangerous as has been represented.—*Supplement to the Pharmacopœia.*

In *Madeira-wine*, the acid is absorbed by adding raw plaster of Paris stone.

*Rhenish*, or *Hock*, is made from scarcely-ripened grapes.

*Burgundy* is made from selected grapes, the bad berries being cut off the stalks, and only the juice fermented.

*Port-wine* is made from grapes without selection, skins trod in a cistern, and stalks together, which, during fermentation, separate, and form a dry head over the liquid, which is drawn out, and casked when the head begins to fall. It is mixed with one-fifth to a fourth of brandy, to enable it to keep.

*Raisin-wine* is made by soaking 1 cwt. of raisins, and 18 gallons of water for a fortnight, stirring every day. Then press, and put the liquor in a cask with the bung loose, till it has done hissing. Add 1 to 2 quarts of brandy, and bung up close.

*English grape-wine* is made from the juice of out-of-door grapes, or from an infusion of 50 lbs. of young leaves or cuttings of the vine, in 8 or 9 gallons of water, adding about 3 lbs. of sugar to every gallon of liquor.

*Gooseberry-wine* is made of 9 gallons of ripe berries, bruised, to 30 gallons of water, soak 24 hours, and strain. To each gallon add 2 lbs. of sugar, and ferment.

*Currant-wine* is made with 70 lbs. of red currants, bruised and pressed, brown sugar 10 lbs., and a small quantity of water. Yields a pleasant red wine, rather tart, but keeping well.

*White currant-wine* is made of a sieve of red currants, or 11 quarts of juice; to each gallon of juice add 3 of water, and to each gallon of liquor add 3 lbs. of sugar, and ferment. Add 1 quart of brandy to 10 gallons of wine.

*Mixed fruit-wine.*—White, red, and black currants, cherries, especially black-heart, raspberries, mixed, &c.; to every 4 lbs. of the bruised fruit add 1 gallon of water, soak for 3 days and press. To each gallon of liquor add 3 lbs. of yellow sugar, ferment, and add to every 9 gallons 1 quart of brandy.

*Metheglin* is made by mixing 1 cwt. of honey with boiling-water, to fill a 27-gallon cask. Stir it for a day or two, add yeast, and ferment.

*Mead* is made from honeycombs, from which honey has been drained by boiling them in water, and this is fermented.

*Cowslip-mead* is made by boiling 30 lbs. of honey in 15 gallons of water; when cold, add sliced lemons, and 14 gallons cowslip pips, yeast half a lb. and sweet-briar a handful. Ferment and bottle.

*Cowslip-wine.*—Add to every gallon of water 3 lbs. of white sugar; stir in yeast, and ferment a day and a half. Add a gallon of cowslip flowers, and the rind and peel of 2 lemons or Seville oranges to each gallon, strain the third day, and continue the fermentation.

*Elder-wine* is made by boiling 8 gallons of the juice of the berries, 12 gallons of water, and 60 lbs. brown sugar. Add yeast, and ferment; then add 2 quarts of brandy, and bung up for 3 months.

*Ginger-wine* is made of bruised ginger 12 oz. and water 10 gallons, boiled for half an hour. Then add sugar 28 lbs., and boil till dissolved. Cask the liquor with 14 sliced lemons and a quart of brandy, add a little yeast, and ferment. Bung it up for three months, and then bottle.

**WIND**, is caused by some rarefaction of the atmosphere, which, causing an ascent, leaves a vacuum, and a current takes place towards the spot. The passage of the sun, in parallels 23½° on each side the equator, produces such rarefactions and general currents, of which others are branches, or deflections.

Within the limits of from 28° to 30° on each side of the equator, the movements of the atmosphere are carried on with great regularity; but, beyond these limits, the winds are extremely variable and uncertain. It appears, however, that, beyond the region of the trade-winds, the most frequent movements of the atmosphere are from the south-west in the north temperate zone, and from the north-west in the south temperate zone, over the ocean, and in maritime countries. In the interior of continents, they are influenced by a variety of circumstances, among which the height and position of chains of mountains are not the least important. The course of the winds, in the North Atlantic, are taken from a statement of passages made from 1818 to 1827, embracing a period of ten years, and comprising 188 complete voyages, and in the Encyclopædia Americana.

The passages from New York averaged, in

| | | | |
|---|---|---|---|
| January | 24 days. | July ..... | 24 days. |
| February | 24 | August ... | 23 |
| March .. | 23 | September | 25 |
| April ... | 24 | October .. | 24 |
| May .... | 24 | November | 22 |
| June .... | 25 | December | 24 |

Passages from Liverpool averaged, in

| | | | |
|---|---|---|---|
| January | 42 days. | July ..... | 40 days. |
| February | 40 | August .. | 36 |
| March .. | 36 | September | 33 |
| April ... | 34 | October .. | 37 |
| May .... | 35 | November | 38 |
| June .... | 38 | December | 48 |

**WINDMILLS**, are machines for grinding corn, and dressing flour for the baker, by the force of wind. The angle of the sails with the axis should be from 72° to 80°. They often move 30 miles an hour.

From the experiments of Smeaton, it appears that the following positions are the best. Suppose the radius to be divided into six equal parts, and call the first part, beginning from the centre, one, the second two, and so on, the extreme part being six:—

| No. | Angle with the Axis. | Angle with the Plane of Motion, or Angle of Weather. |
|---|---|---|
| 1 | 72° | 18° |
| 2 | 71 | 19 |
| 3 | 72 | 18 |
| 4 | 74 | 16 |
| 5 | 77½ | 12½ |
| 6 | 83 | 7 |

As it is necessary that a windmill should face the wind from whatever point it blows, the whole mill is made to turn upon a strong vertical post, and is therefore called a *post-mill*; but, commonly, the roof or head only revolves, carrying with it the windwheel and its shaft, the weight being supported on friction rollers. In order that the wind itself may regulate the position of the mill, a large vane, or weathercock, is placed on the side which is opposite the sails, thus turning them always to the wind. But, in large mills, the motion is regulated by a small supplementary wind-wheel, or pair of sails, occupying the place of the vane, and situated at right angles with the principal windwheel. When the windmill is in its proper position, with its shaft parallel to the wind, the supplementary sails do not turn. But, when the wind changes, they are immediately brought into action, and, by turning a series of wheelwork, they gradually bring round the head to its proper position.

On account of the inconstant nature of the motion of the wind, it is necessary to have some provision for accommodating the resistance of the sails to the degree of violence with which the wind blows. This is commonly done by cloathing and uncloathing the sails; that is, by covering, with canvass or thin boards, a greater or smaller portion of the frame of the sails, according to the force of the wind at different times. A method has been devised for producing the same effect, by altering the obliquity of the sails; and windmills have been so made as to regulate their own adjustment by the force of the wind. If we suppose a windmill, or windwheel, to consist of four arms, and that the sails were connected to these arms at one edge by means of springs, the yielding of these springs would allow the sails to turn back when the wind should blow with violence; and their elasticity would bring them up to the wind whenever its force abated. This effect has been produced by a weight acting on the sails through a series of levers. A loose iron rod, passing through the centre of the axle of the windwheel, receives the action of the weight at one end, and communicates it to the sails at the other.

When wind is employed as the first mover of machinery, it is applied by receiving it upon sails which are nearly vertical, and which give motion to an axis nearly horizontal, in which case the machine is called a *vertical windmill*, because the sails move in a vertical plane. In the vertical windmill, on the other hand, the arms which carry the sails revolve in a plane facing the wind. In order to make the arms revolve, the sails are to be placed in some direction intermediate between those of the wind and the plane in which the arms revolve. In determining the angle at which the planes of the sails should be inclined to the axis of motion, or the direction of the wind, it is necessary to consider the sail in motion.

WINDPIPE.—*(trachea;)* a cartilaginous and membranous canal, through which the air passes into the lungs. Its upper part, called the *larynx*, is composed of five cartilages, the uppermost of which, called the *epiglottis*, closes the passage to the lungs, when a person is in the act of swallowing.

The two front cartilages of the larynx, the thyroides, or Adam's apple, and the annular, which resembles a ring, may be felt directly under the skin. The various cartilages of the larynx are united to each other by elastic fibres, and are enabled, by their several muscles, to dilate or contract the passage, and perform those numerous motions which render the larynx so important as an organ of the voice. From the larynx the canal takes the name of *trachea*, and, after extending as far down as the fourth or fifth vertebra, it divides into two branches, running to the two lobes of the lungs.

The cartilages of the trachea, by keeping it constantly open, afford a free passage to the air in respiration; and its membranous part, being capable of contraction or dilatation, enables us to receive and expel the air in a greater or less quantity, and with more or less velocity.

WINDSOR-BRICK, is an infusible material, light, and easily cut into desirable forms, with the knife or saw, for the use of chemists and manufacturers.

*Windsor-Soap.*—Melt down 1 ℔. of hard white-soap, and add 10 drops each of oil of caraways, and essence of burgamot. *Or*, with only the oil, or with oils of lavender and of orange.

WIRE-DRAWING, is effected by drawing wire with mechanical force through conical holes of successive fineness, on wheels or drums. Copper bolts and wire are made in like manner; as well as silver, and other wires. Fine silver wire, covered with gold, the millionth or ten millionth of inch thick, is flattened for making gold thread.

WOAD, a continental plant, which yields a blue dye to woollen cloth. The large leaves are gathered, in France, several times in a year, and ground into paste at a mill. It is then laid in heaps to ferment, formed into balls, and dried. The dyers pound it again, and ferment it with water. It is then dissolved in boiling water, and a 20th slaked lime added, by which it ferments, turns blue and red, and finally dyes woollens green, which, in the air, change to blue.

WOLLASTON'S SCALE OF EQUIVALENTS, is an instrument which ought to be in the possession of every experimentor. It displays, at one view, the exact relations of all simple bodies and compounds to one another, and affords an endless text for comparison and useful inference.

WOOD.—The qualities of wood depend much on the state of the tree when cut down. It appears, from experiments upon wood applied as fuel, that trees which have attained maturity without passing into decay, are the best for the production of heat. Thus, the value of an elm of one hundred years is, to that of one of thirty years, as twelve is to nine; that of an ash of one hundred years, to one of thirty years, as fifteen to eleven. When the trees begin to decay, their value rapidly diminishes; thus, if an oak of two hundred years yields wood worth fifteen francs per corde, a tree of the same kind, passing to decay, yields wood only worth twelve francs. When the wood is used for other purposes, the advantages conferred, by a mature but healthy state, are still more considerable.

The common *elm*, growing in a forest and in good earth, acquires its full increase in about one hundred and fifty years, but it will live many ages, even five or six hundred years. Large forest-elms are cut down with advantage when of an age between one hundred and one hundred and thirty years, and then furnish a large quantity of building wood. The duration of the life of the elm depends much upon the soil; in a dry soil it becomes aged, as it were, in forty, fifty, or sixty years. Elms which have been lopped, live for a shorter period than the others. Those which grow by the road side, or in thin plantations, may be cut when seventy or eighty years of age. In general, the increase of hard woods, as the oak and the elm, is small at first; it successively augments until the twentieth or twenty-fifth year, is then uniform until the age of sixty to eighty years, after which it sensibly diminishes.

The following signs are always indicative of decay in trees. When the top branches are withered, the decay of the *central* portion of the wood has commenced; but when the bark detaches itself from the wood, the progress of destruction has made great advances. When the bark becomes loaded with moss, or lichens, it is also a proof that the tree is in an unhealthy condition; but which may, in some measure, be overcome by detaching these parasitical fungi from the surface. But if the sap flows out freely from cracks in the bark, it is a sign of early destruction of the tree.

Woods are classed under three different heads: hard, resinous, and white woods; and, as the result of numerous experiments, most of the hard woods lose, by drying, two-fifths in weight, and one-twelfth in bulk, while the resinous and the white woods lose about a half of their weight, and a sixth of their bulk.

Bevan's experiments on the strength of wood have been arranged by him in a tabular form. Having occasionally found part of the larger end of the wooden bars drawn out in a cylindrical shape, when the lateral adhesion was less than the longitudinal strength; the number of pounds expressive of the strength is, in these cases, short of what is due to the specimen, and, in the table, these are expressed by (+), as to the other bearing; sometimes the specimen broke during the motion of the weight, and therefore would have separated under a less force, with more time; these are marked (—).

| Species of Wood. | Spec. Grav. | Strength in lbs. |
|---|---|---|
| Acacia | ·85 | 16,000+ |
| Ash | ·84 | 16,700— |
| Do. | ·78 | 19·600 |
| Beech | ·72 | 22,200 |
| Birch | ·64 | 15,000 |
| Box | ·99 | 15,500 |
| Cane | ·40 | 6,500 |
| Cedar | ·54 | 11,400 |
| Chestnut (Horse) | ·61 | 12,000— |
| Do. (Sweet) | ·61 | 10,500 |
| Damson | ·79 | 14,000 |
| Deal (Norway Spruce) | ·34 | 13,100— |
| Do. | | 17,060— |
| Do. (Christiana) | ·46 | 12,400— |
| Do. (Do.) | ·46 | 12,300— |
| Do. (Do.) | ·46 | 14,000 |
| Do. (English) | ·47 | 7,000— |
| Elder | ·73 | 15,000 |
| Hawthorn | ·91 | 10,700— |
| Do. | | 9,200 · |
| Holly | ·76 | 16,000— |
| Laburnum | ·92 | 10,500— |
| Lance-wood | 1·01 | 23,400— |
| Lignum Vitæ | 1·22 | 11,800— |
| Lime-tree | ·76 | 23,500 - |
| Mahogany | ·87 | 21,800— |
| Do. | ·80 | 16,500— |
| Maple | ·66 | 17,400 |
| Mulberry | ·66 | 10,600 |
| Oak (English) | ·70 | 19,800 |
| Do. | ·76 | 15,000 |
| Do. (old) | ·76 | 14,000 |
| Oak Pile, out of the River Cam | ·61 | 4,500 |
| Oak (blk. Linc. Log.) | ·67 | 7,700 |
| Do. (Hambro') | ·66 | 16,300 |
| Do. (Do.) | ·66 | 14,000 |
| Pine (Petersburg) | ·49 | 13,300 |
| Do. (Norway) | ·59 | 12,400 |
| Do. (Petersburg) | ·55 | 13,100 |
| Poplar | ·36 | 7,200 |
| Sallow | ·70 | 18,600 |
| Sycamore | ·69 | 13,000 |
| Teak (old) | ·53 | 8,200 |
| Walnut | ·59 | 7,800 |
| Willow | ·39 | 14,000 |
| Yew | ·79 | 8,000 |

To preserve wood from damp, melt 12

resin, 3 sulphur, and 12 linseed-oil, add ochre for colour, powder all; put two coats, one hot.—*See* TIMBER, TREES, DRY-ROT, &c.

It appears, that stakes of firs, oaks, and of *Robina Pseud-Acacia*, were, after being five years in the ground, not the least altered; while, after two years, almost all others, as *Tilia* (lime-wood), *Betula alba* (white birch), *Carpinus* (hornbeam), *Acer* (maple), &c., were more or less rotten. *Salix Juglans*, *Fagus*, *Castanea*, *Platanus*, lasted four years. Those stakes which had their bark left on, or were, as usual, oiled or tarred, did not keep any longer than those without either bark or preparation; but those which were burned a little way above and below the ground, stood well, particularly when tarred. This being the cheapest method, it will be more in use than the following, which, however, is the best way for preserving wood. It must first be painted with oil-colour, and, after it is dry, a sheet of iron, about 16 inches long, must be put round it, so as to be as much in the ground as above it, and then the whole should be painted again.

WOOL, AND WOOLLEN MANUFACTURES.—On the wool-trade, and woollen-manufactures of Yorkshire, the Editor wrote the following observations, in the respective buildings, in the winter of 1828-9. Ten or twelve years since, Leeds had no pretentions to compete with the west of England in the manufacture of superfine cloths. Till about that time, the cloths made at Leeds were chiefly made of British wool, narrow in measure, and known in the world under the name of Yorkshire, or narrow-cloths, a description of which always bespoke inferiority. They served for servants' clothes, and were used only for cheap purposes.

In Yorkshire previously, the spinning, weaving, dressing, &c. &c. were wholly performed by hand. The cloth-makers were scattered through the villages of the West Riding, and having spun their wool, and wove their cloth, they brought it, by hundreds, to Leeds, on market-days, by every variety of simple conveyance.

At length, extensive buildings were erected for their accommodation, called CLOTH-HALLS, where every maker had his fixed stand, and on Tuesdays and Saturdays 1500 or 2000 brought their unfinished fabrics for sale in these halls. This practice still continues, but on a very reduced scale; for the numbers now, compared with those who used to come to this market, is not above 1 for 20, and these are care-worn persons, struggling with their hands and small capitals, against steam and water power, and large capitals.

The change has arisen from the invention of machinery, from the powers of the steam-engine, and from the obligation of economizing labour, so as to sell cheap, and force trade by underselling all others.

About fifteen years since, an enterprising individual in Leeds, of the name of WILLIAM HURST, at the time a journeyman cropper, conceived the idea of competing with the west of England in the manufacture of fine cloths. Of course, the domestic makers in this neighbourhood were as untractable as those in the west, and therefore Hurst was obliged to undertake the entire fabric, from the fleece to the finishing for sale, before he could effect his purpose.

Leeds now abounds in similar manufactures to that of Hurst and Heycock. Most of them not only make finer cloths than ever were before made in England, but they make it nearly 50 per cent. cheaper than at any former time.

I saw Mr. Hurst, and he and his partner shewed me through their fine and extensive establishment.

As little but Saxony or German wool is used in the production of fine cloths, so the trade of the English wool-stapler for clothing is superceded, and his only business is for combing purposes, as hosiery, worsted-stuffs, blankets, carpets, and flannels. On the contrary, the agents for the importation of German wools have latterly become proportionately important. These wools are grown in and around Saxony; the most esteemed, Brunswick, Mecklenburgh, Hanover, Prussia, Silesia, Austria, and Hungary. They are produced from a Spanish breed, imported, within a few years, into those countries, the flocks of which are now cherished for their fleece only.

The woollen manufactories of Leeds are the most extensive in England, or in any part of Europe. Two or three of them cover above an acre of ground, and every part is occupied by buildings four or five stories high, and filled with machinery and with men, women, and children, in the several operations, to the number of 4, 5, or 600.

In my view of them, I made my election of the original manufactory of Messrs. HURST and HEYCOCK, not only because it is one of the largest in Leeds, but, because I was told, that they make the finest cloths, and adopt the most novel and skilful machinery, being themselves inventors, or patentees, of several contrivances for abridging labour or perfecting results.

There are other manufactories of consequence, as those of the Gotts, York, and Sheepshanks; Hurst, Bramley, and Co.; Halliley, Stanley, and Co.; Hargreaves, Bruce, and Co.; Willans; Ripley and Ogle; Nevins; Brancker and Co.; and Shann and Co.; all of whom have steam-engines, and make the finest as well as coarse cloths.

Hurst and Heycock purchase wool as imported, and pass it through nearly thirty sets of hands, or processes, in a period which usually occupies six or eight weeks, in the regular succession of the several operations. No person could believe it, who did not see the operations, that the coat upon his back had been knocked about as it has been. First, in the wool, before it is spun into the warp and woof; second, after it is woven, as by beating, in milling, by scrubbing, scouring, cropping, boiling, pressing, &c. &c. before it is finished for sale!

The circumstance which first surprised me was the fact, *that all fine cloths, and all clothing worn in England, are made, and must be made*, from Foreign Wools. I had been accustomed to infer, from reading books, that wool was the permanent staple of England, that our well-secured flocks of sheep were the best resource of the country, and that our broad-cloths were the result of this primary national staple. The flourishes of authors and public men on this subject, the poem of Dyer, and the laws of the staple, passed, in the time of our first Edwards, seemed to assure me of this fact; but, on entering the extensive wool-rooms of Hurst and Heycock, my error was soon corrected. I learnt that the chief part, 19-20ths of the wool used in the production of superfine cloth, in Leeds, is actually brought from Saxony; that even little Spanish is now employed; that English merino has deteriorated and is unfit for superfine cloths, and that Botany-bay and Peruvian wool serve only for occasional mixture; and, in fine, that English wool, even of the best sorts, are *utterly useless* in the manufacture of cloth. It appeared, on explanation and examination, that English wools are not only too coarse and too long in the staple for such woollen cloth as is universally worn in dress, but, that *it will not mill;* and I was shown the instance of a piece of cloth, dyed green, made entirely of English wool, with a heading or ending of Saxony wool. In milling, the heading was reduced to 42 inches in width, while, after three days milling, the body of the piece remained 72 inches in width. I saw the piece, and it is a notable and decisive proof of the inutility of English wool, even South Down, for making useful cloth.

In fact, it appears that Saxony wool produces cloth, which may be sold from 11*s*. to 35*s*. per yard; that Spanish wool will produce cloth, worth from 8*s*. to 12*s*.; that Botany-bay will yield an equal value; but that English wool will only suit army coating, and fetch only from 3*s*. to 8*s*. per yard.

The value of wool for superfine cloths depends on the *fineness* and *softness* of the fibre, and on the *shortness* of the staple, neither of which qualities is possessed by English wool.

The importation of Saxony wool, or the wool grown in the middle and Northern districts of Germany, is, therefore, immense. Its price has fallen, since the fatal panic, full 40 per cent., and it sold in November, 1828, (at the time when this article was written, from 1*s*. 9*d*. to 5*s*. or 6*s*. per lb., according to quality. I was told, that for every 20 millions pounds imported, the proportion of 16 millions is now Saxon, or German.

I learnt, also, the curious facts, that all wool grown on a chalky soil has a harsh fibre, and will not mill, that the fleeces of dead sheep are less silky than fleeces taken from the living animal, and that the merino breeds, from which so much advantage was expected, have, in the produce of wool for the manufactories, completely failed.

I can scarcely affect to carry my readers through the 26 distinct operations of this woollen manufactory. I fear to weary them with such details, since I cannot, after all, interest their eyes with the complicated and overpowering machinery itself, nor impress on them an accurate idea of the noise and bustle of the operations. Such a manufactory is a world by itself, and the people employed seem to belong exclusively, not to the general world, but to a world of their own.

1. There are men employed in *sorting* the wools of many qualities and countries.

2. There is a machine of many rollers with teeth, for what is called *devilling*, or willowing the wool, which means the opening of its locks.

3. There are machines for *scribbling* or combing it.

4. There are others, called *carders*, for forming slivers, or short rolls of the wool.

5. There is a travelling or sliding apparatus called a *billy*, for *slubbing* or drawing out the slevers into six times their length.

7. The slubbings put on spindles are then *spun* by means of *mules*, machines well known in cotton factories, and invented by Crompton, who lately died in poverty at Bury.

8. The thread is then farmed, by women, into *warps* for the looms.

9. The weavers *size* and dry these warps or webs.

10. They then fix them on their beams, and *weave* the cloth, which, as delivered by them, is little better, or firmer, than stout flannel.

11. This cloth is then *scoured*.

12. It is afterwards taken to the *burlers*, a room of women, who pick the surface and clear the whole from foreign substances.

13. The cloth is then *milled*, a process most curious, in which, by being beat with wooden hammers of 3 cwt. each, for 15 or 24 hours, the threads of the web are driven together, and the width reduced from 11 quarters, or 8 feet 3 inches, to 5 feet. The machines are called *stocks*. The backs are made of cast-iron, according to an improvement of Kilburn of Holbeck, and the circular blows of the hammers, and the harmony of the result is astonishing.

14. The next process is to confer *a soft nap* on one side of the cloth, and this is effected by the use of a species of thistle, called *teasels*, the heads of which are placed in frames, put upon cylinders, and against these the cloth is worked for 6 or 7 hours, by which means a delicate and lustrous nap is raised, which constitutes the beauty of cloth.

15. It is then *boiled* in water for two hours, by which its glossy surface is fixed.

16. It is then *cropt*, or reduced to a level surface, by means of sheer spiral blades, fixed upon a cylinder, invented by Mr. I. Collier of Paris, a process formerly performed in a very clumsy manner by huge sheers.

17. It is then boiled, *tentered*, and dried in a house, at a heat of 100° or 120°.

18. It is then worked, or *raised* again, by means of teasels, called *moysing*.

19. It is, finally, *cropt* lengthwise and breadthwise.

20. At this period it undergoes various *brushings*, by machines contrived for that purpose.

21. Imperfections are then *fine-drawn* by men.

22. It is *pressed*, by a Bramah's hydraulic press, with a force of 100 tons, between hot iron plates.

23. The pressed face is taken off by *steaming* and *brushing*.

24. It is *cuttled* or folded into lengths, as pieces for sale.

25. If blue, the wool is dyed before the manufacturing.

26. If black, it is dyed after being milled.

Such are the numerous steps by which a piece of superfine woollen cloth is produced. It is 6 weeks in its course, or in work. The weaving occupies 3 or 4 weeks, and is the only part of the process which depends on the workman.

These powers of production have enabled Messrs. Hurst and Heycock lately to reduce the number of their hands from 56 to 10 in spinning, in burling from 150 to 19, and in raising from 40 to 24. This economy of labour empowers them to manufacture cheaper than others; hence, to manufacture in greater quantity, and even to increase the number of their hands.

I was advised, subsequently, to view another woollen cloth manufactory, which enjoyed, among my scientific friends a high reputation, for the superiority and novelty of its machinery. The name of this firm is Halliley and Stanley. Every process is by them performed in the best manner; the various machines are the most perfect of their kind.

The stages of the manufactory were in the main like those described at Hurst and Heycock's, but performed in a better light, and, to my eye, with greater precision. The novelties were some self-acting mules, made by De Jongh, a very ingenious machinist of Manchester, for which he has a patent. The frame runs back by itself, and, when out, a slide puts the drums in motion, and performs the usual degrees of twisting required for the warp, or woof. It then puts up by itself, and by a peculiar movement takes hold of the slubbings, and runs out as before. The shaping of the thread on the bobbins is effected by a cone at each end of the frame, which, in moving backward and forward, raises a bar connected with the bobbins. Mr. Stanley assured me that as much spinning could be effected with De Jongh's mules, by 1 or 2 attendants, in 3 days, as could be effected by 5 men in 8 days by jennies.

I also saw, in the same room, some power-looms for weaving cloth, made by Sharpe and Co. of Manchester. The directing parts are of course very simple, for the loom itself is the simplest of all machines. The beam is moved backward and forward with great precision, and brought home with more force than by hand, and, hence, the cloth is firmer. The shuttles are moved by a cross string exactly as in broad hand-looms, and the pull is made by the motion of the beam itself. It appeared, on the testimony of the weaver, who was superintending a wide-loom thus at work, that it made 6 yards a day, or double what he could make of the same cloth by hand.

The mules with 200 bobbins cost 100 guineas each, and the looms about 20 guineas, or more than double the ordinary cost.

The quantity of cloth made by Hurst and Heycock is about 3000 yards, at from 6*s*. to 20*s*., per week; and by Halliley and Stanley about 1000 yards, at about 15*s*. I was surprised at the moderate price of the best cloths. I saw as fine broad-cloths as a gentleman could wish to wear, at 12*s.* or 13*s.* per yard, for which it is usual to pay through the tailor at least double.

The general mode of doing business at this time, in Leeds, is for the manufacturer to begin and complete the fabric on his own premises. Some of them vend by travellers to drapers, through the kingdom; while others sell the whole of their manufacture to merchants, or factors in Leeds, or to factors in London, which last are the same houses that buy up the fabrics of Leicester, Derby, and Nottingham, and who, paying by present bill at 3 months, enable the manufacturer, at trifling profits, to make quick returns of his capital.

It is computed that there are, in and round Leeds, at least 200 steam-engines, which, on an average, may be estimated at 20 horse-powers. Messrs. MARSHALL alone have 276 horse-powers in six engines. There is also much water-power, equal, perhaps, to a fifth of the steam-engine power. Then, taking each horse-power as equal to that of five men, we shall, in labour thus performed, have a total equal to that of 24,000 men. But, as men could not work night and day, and would, within 12 or 13 hours, require to be relieved, so the labour is equal to that which could be performed by 48,000 men. The expences are considerable, for each engine consumes 10*s.* worth of coals, and costs, perhaps, as much more in repairs and attendance; but the expence is more than compensated by the undeviating regularity of the labour. The setting on of the engine is the signal which calls every one to his or her post, and, while it is going, there can be no relaxation without considerable mischief. Hence, perhaps, twice as much more work is performed under the severe despotism of a steam-engine, as could be performed by the best exertions of manual labour. It is, in truth, so unerring, that a great manufacturer assured me that his engine did not deviate in its number of strokes five minutes in a week, and, of course, the rate of his machinery, and his production, would be equally regular. It is this circumstance which renders all productions so cheap and so excessive, while it imposes a degree of incessant attention and slavery on all employed, which at once astonishes and appals those who are used to labour which depends on the human will. Perhaps, therefore, the manufacturers of Leeds save, at least, the wages of three times 24,000 men in the mere appropriation of the powers of steam and water, equal to 72,000*l.* per week in wages of labour. The machinery also multiplies the product ten-fold, and every child superintends as much produce, at half the wages, as formerly employed ten adults, which, as each engine employs about 50 hands, so the machinery saves the labour of 200 times 50, or the wages of another 10,000 × 2. We cannot wonder, therefore, at the comparative cheapness of articles thus manufactured, and at the utter impossibility of manual labour competing with machinery.

The intercourse of Leeds with the world is indicated by the fact, that 80 stage-coaches leave it every day, for London, York, and other places. Also, that 14,000 vessels, barges, &c. carrying from 30 to 36 tons, depart annually for Hull, York, Liverpool, &c. The water-conveyance is the most perfect of any in the kingdom. The Aire and Calder Navigation communicates with the Eastern ocean, and the Leeds and Liverpool connects it with the Western ocean, which communicates directly with every canal in the central part of the kingdom.

There are, in Leeds, about twenty STUFF MERCHANTS, who buy of stuff-weavers in the grey or grease state, dye, and finish for sale. All kinds of worsted stuffs are the staple of these houses, as plain and twilled bombazettes, shaloons, lustrings, florentines, tammies, moreens, calimancoes, camlets, plaids, merinos, &c. The prices are about 30 per cent. less than they were 12 or 14 years ago, and the fall has been gradual, or about $7\frac{1}{2}$ per cent. in the last year. The causes are ascribed to the general rise in the value of money, to the introduction of machinery into the spinning, weaving, cleansing, &c., and to the low price of *British wool*, of which stuffs are made. Again, machinery augments the produce and the competition, and tends to the reduction of the profits of all parties concerned in the fabric and sale of the articles; hence, profits have been cut down in every department, from $7\frac{1}{2}$ and $12\frac{1}{2}$ per cent. to 2 , or even less.

The worsted for this trade is chiefly spun at and near Bradford, where there are from 20 to 30 great spinning-mills, and there are others in Lancashire. The weaving is performed at Bradford, Halifax, and the adjoining villages, and there is a STUFF-PIECE HALL at Bradford, as a market for the small weavers. The finishing and sales are then conducted at Leeds. The house of ALDAM, PEASE, & Co. finish and dye for themselves, but other merchants employ dyers and finishers. I visited the finishing works of that firm, and was much surprised at the 12 operations which a piece of woven stuff undergoes before it is folded up for the market, and no less delighted at the ingenuity and precision of the operations.

The first process is to singe off the superfluous fibres of the wool, and this is effected by drawing the piece rapidly over a convex plate of iron, which forms the top of an oven, and is heated red-hot. It smokes, but is not scorched, and when both sides have passed in this way, the surface is even. It is then rolled tight, soaked in hot-water, and boiled. Afterwards it is scoured, stocked, or milled, and pressed between rollers to take out the moisture. It then passes through a mordaunt, and is dyed; care being taken, in blacks, to expose it twice to the oxygen of the air, and stocked again. The drying is performed by four iron-rollers, heated by steam, passing through them in worms, and the piece is at once carried round the four, and delivered dry for pressing, which is performed by one of Bramah's efficient machines, with a force of 2, 3, or 400 tons.

All these operations are performed in this establishment, by about 50 or 60 men, on about 2000 pieces of 28 yards per week, and often more. It was calculated that the West Riding makes from 30,000 to 40,000 pieces of stuff per week; but, I was told that Norwich retains the manufacture of silks and worsted articles, as bombazeens and crapes, also of camlets for the East India trade; but, even for these, the worsted is chiefly spun by the machinery of Yorkshire.

Every branch of industry is pursued with success at Leeds. Where so much machinery is wanted, it is required that it should be made on the spot, and the complication of the operations requires that the makers should be original thinkers, and ingenious mechanics. There are four principal makers of machinery, and many on a smaller scale. I had the privilege of visiting the work-shops of Cawood and Sons. However ingenious are the manufactories, and the machinery used in them, yet these makers of the machines themselves exhaust the science of mechanics, and apply all the manœuvres for directing power, and all the means of rendering it effective. In their work-shops, cogged-wheels are cut in iron and brass in all proportions, iron-rollers are fluted, jointed chains of brass in machines, for preparing flax, and all the varieties used in the flax manufactory, are constructed in perfection.

At Burley Mill, two miles west of Leeds, stands a considerable, and perhaps the most considerable, stuff-weaving manufactory in the United Kingdom, the proprietor of which is Mr. T. W. Stansfield. The whole of the weaving, winding, &c. &c. is performed by power, at suitable times by water, and at others by a powerful steam-engine.

On three floors there are about 140 looms in each, or about 400 altogether. The looms are smaller than the machines in other manufactories, and each loom employs a girl or boy, to watch the threads and pick the work.

Nothing can be more astonishing than to behold, at one view, in one room, 140 weavers' beams performing their oscillations, the shuttles flying backward and forward, and the straps and pulleys of each turned by the shafts from the central-wheel. It was overwhelming, as an exhibition of useful power, and still more so in the united noise.

The number of men, women, and children, are between 5 and 600; and about 400 are girls, between 8 and 14, and boys from 9 to 14. They earn from 4*s*. to 12*s*. and are paid by the piece, which, according to fineness, runs from 14*d*. to 4*s*. The hours are severe, and only 1¼ hour is allowed for 3 meals, between 6 and 7; but, as they are paid by the piece, the majority would, I was told, vote for such short meals.

The worsted used in this mill is spun at Bradford and Manchester, and it consumes the long wools of British growth, all of which are useless in the manufacture of woollen cloths. 400 looms weave, on the average, about half a piece, or 15 yards a-day; hence, the production must be 6000 yards a-day.

The spun-worsted consumed is from 7 to 8000 lbs. weight per week, and the wove stuffs, in all varieties of bombasetts, moreens, lustrings, and merinos, fetch from 6*d*. a yard to 3*s*. 6*d*. according to breadth and quality. It is supposed that the quantity of these fabrics, made in and near Bradford by hand-looms, are full 20 times as much more than is made by Mr. Stansfield.

At Mr. Wood's worsted-spinning factory, at Bradford, are employed about 700 hands in assorting and picking wool, in combing by hand, and in spinning by machinery, in all numbers, up to 110; *i. e.* 110 times 560 yards, or 35 miles in length, to the lb. of worsted. Nothing could, in every sense, be more grateful than the exhibition of this manufactory. The children were clean and healthy, and all the rooms spacious and airy. A little urchin told me, in reply to a question of Mr. Wood's, that she received 5*s*. per week for attending the spindles; and he afterwards shewed me his wages-book, by which it appeared, that the numerous females get from 6*s*. 6*d*. to 11*s*. per week. I learnt, however, that they begin at 6 and leave off at 7, the engine standing still only 20 minutes for breakfast and 40 minutes for dinner; but, in the worsted-mills, generally, the engine stands but a single half hour for dinner, and this half hour is the only respite from 6 in the morning till 7 or 8 o'clock at night.

At Bradford, Messrs. Wade, Son, and Co. have perfect specimens of *Combing*-machines. They had employed one since the late strike among the combers, and they had commenced the use of a new one about three months before. The first differs only in some minute circumstances from the carding-machines used in the woollen manufactories; but the new machine, invented by Anderton, works on the principle of the combs used by hand-combers, and combs a pack or 240 lbs. per day. It consists of a revolving cylinder, provided with rows of wire teeth 30 inches long, which catch the wool as it is carried toward them, and every comb becomes charged with finely-drawn wool. The combs are then cleared or drawn by means of a very ingenious machine, invented by Gilpin, of Sheffield.

Mr. Wade's manufactory is the only one through this district which makes and finishes stuffs from the fleece to the saleable piece. Some weave it in the gray state, while others finish and dye; but Messrs. Wade perfect the article in the same establishment.

At Halifax, Mr. Dawson has a fine establishment for making thick worsted yarn, adapted to carpeting, sadlery, &c. The first process is by machine-carding, instead of hand-combing, and the yarn is then sold to manufacturers.

All these manufactures in and near Halifax confer on it a considerable manufacturing and commercial character, and, as there are numerous water-wheels on the Hebble and Calder, so there is scarcely any district in which there is more industry and more variety of production. Hence, the flatness of a single trade does not produce the same mischiefs as in places where there is but a single staple. They also make and prepare card-teeth, by machinery, worked by steam-power.

Of the 100,000 inhabitants of this vast parish, two-thirds are engaged in the worsted, woollen, and cotton manufactory. Mr. Jonathan Akroyd, of Halifax, and his brother, Mr. James Akroyd, at Old Lane, have very extensive and complete stuff-manufactories, in which weaving is effected by power-looms (extending, generally, to stuff-weaving and the weaving of cloth;) since machinery, in every application, produces more work in the same time, and also more even work. It is, therefore, scarcely possible for hands and arms to compete with an efficient machine.

At Birstall, and in the parishes adjoining, there are mills of considerable extent, which prepare wool for the domestic manufacturer, at a fixed price per lb., *i. e.* about 1½ for blanket wool, and 3*d*. 4*d*. and 6*d*. for broad-cloth wool. These establishments put the domestic clothier on the same footing, as to machinery, as those factories which perfect the fabrics. I passed through one of these mills, kept by Mr. Nussey. Their machinery consists of scribblers, carders, and billies. The girls who feed the scribblers and carders get 7*s*. a week; the children who place the cardings get 3*s*. 6*d*.; and the man who works the billy, gets from 20*s*. to 30*s*. Weavers get from 12*s*. to 16*s*. in this neighbourhood. A set of machines, scribbler, carder, and billy, costs about 500*l*., and, taken with the building, steam-engine, &c. about 1000*l*. to a billy. Scouring and fulling are also performed in these mills, at a fixed price; hence, the small domestic manufacturers who are scattered over the entire district, enjoy every facility, and, in truth, make as sound cloth as the perfect factors. But, as the profits are very small on the entire business, so the limited concerns of these manufactories leave them very bare wages for their labour and skill.

At Dalton, near Huddersfield, I visited the great valentia and toilinette manufactory of Senior and Son.

The valentias have a cotton warp, or a cotton and silk warp for the silk pattern, and the weft is worsted; but, in toilinettes, the weft is woollen yarn. The weaving is effected like carpet-weaving, by means of a witch or draft, a cylinder stuck with pegs, like the staples in a barrel-organ. This is turned by the treadles of the weaver, and the silk threads of the warp are thereby so changed in position as to determine the pattern. A man can weave from 2 to 4 yards in a day, by which he gets from 12*s*. to 20*s*. a week, exclusive of winding. The piece, however delicate, is then scoured twice in soap and hot-water, dried, tentered, and pressed for sale. The widths are about three quarters of a yard, and the prices, at the manufactory, are from 4*s*. to 6*s*. per yard. It is imagined, that from 1500 to 1800 pieces, of 24 yards each, are made near Huddersfield every week.

There are other articles of fancy cloths made near this place, as a most delicate one by Nowel, and by Shaw, called cassinetes, made of cotton warps and woollen yarn wefts, but all of one colour, adapted both to waistcoats and trowsers.

There are other manufactures called woollen cord, also with a cotton warp and woollen weft; a sort of striped fustian, but with a woollen face. In the fabric of valentias, which have the gloss and fashion of silk, much British wool is used.

Huddersfield adds, to a vast manufacture of low cloths, a very extensive fancy manufactory, partly wool and partly silk. About 40 years ago, a few patterns of a new article appeared here, intended for vesting, composed of different colours on a dark ground; the representation of a natural object had been effected, in the process of weaving, such as the leaf of a plant, a sprig, a white spot, or a stripe of different colours. It is good taste to imitate nature, and, of course, an extensive demand of the article soon followed. They were soon imitated and exceeded by the manufacturers in Denby, Skelmanthorpe, and other places, with warps of woollen and weft of the same material. The first was a rude essay, an important improvement quickly followed, in the substitution of cotton instead of woollen warps; the designs were varied, and new colours introduced, which were frequently changed for other colours, to meet the caprice of fashion. The names of the first articles were swansdown spots and spears, &c. The colours were dyed the delicate buffs, auroras, greens, pinks, rose-colours, &c. frequently out of doors, in a vessel of iron set in brickwork, in a very rude manner; with a little fustic, (*morus tinctoria*) solution of indigo and alum, they produced good bright shades of yellow and green, and an infinite variety of other shades. With killed aquafortis or nitrate of tin, (procured from the dyers of scarlet,) and cochineal, they dyed pink, salmon-colours, &c. Black, from logwood-chips and copperas. Drabs, by varying the proportions of logwood, fustic, and copperas. The same processes are pursued at this day, but on a larger scale, and with more care in the manipulation.

From this humble original the fancy-trade sprung up, and the third part of the population around Huddersfield are now employed in this branch of industry. The round number cannot be less than 16,000 looms. The beautiful patterns of valentias, which ornament drapers' windows wherever you go, are manufactured here, from warps of silk or cotton, and worsted weft. The designs being either imitations of the silk, vesting of Spitalfields, or original from the pattern-loom of the fancy-maker of this neighbourhood.

The worsted is spun at Bradford, and it comes to the maker in hanks; it is scoured and dyed of various colours, and delivered out to the weaver, who works it up at home, and returns it to the master, who burns off the long fibres from the surface by means of a cylinder of iron heated nearly to redness, over which the piece is drawn. He then cleans away the ashes from the surface by passing it through a solution of soap, dries, presses, (in Bramah's hydraulic,) and sends the piece as quickly as may be to its destination.

In fabricating toilenette the wool is carded and slubbed at a public mill, spun, hanked, scoured, and dyed, sent to the weaver, the face of the cloth polished by a regular finishing, the fibres laid parallel, pressed, &c. &c.

Cassenette, made of wool and cotton, or wool and silk for waistcoating, with cassimere fabricated altogether of wool, dffers from valentias and toilenette, in having the whale or twill thrown across or diagonally; it is effected by alternations in the motion of the feet, upon the treddles, which are used for opening a space through which the shuttle may be thrown to carry the weft;—this is the kind manufactured by Mr. Nowel, of Farnley Wood. Senior and Son have also very extensive works for all the fabrics of this vicinity. Frost and Nelson, also, produced shawls from Bradford-spun worsted of miraculous delicacy, and, in fact, not exceeded by cashmere.

At Huddersfield, I saw public or joint-steam-engines, in the building for which different persons have a room and a shaft, for their peculiar purposes; and the proprietors take in job-work, for those who have not an engine of their own. In this, and other ways, the division of labour in this district is carried to its limit.

The best wool is that which approaches the belly of the animal. Cod wool is that of very young lambs. Rabbits' fur is much used in hat-making, the backs and sides *best*; the bellies and sides seconds. Hare fur is also much used. Beavers' fur has 6 or 7 qualities, the best *ruffing*. All these filaments, or hairs, are formed of lamellæ, or scales, from the root to the point, a structure which may be felt by drawing a hair both ways between the fingers. The union of these scales gives rise to the consistence of felting with bows, and also to the operation of milling, by beating with a hammer.

Mr. Wells has taken a recent patent for a gig-machine, for raising naps by a straight perpendicular, instead of a circular motion of teazles, brushes, or cards, and it may be regarded as an improvement.

It is but justice to state, that, in the western counties, which originally raised the fame of English broadcloths, the same perfection of machinery is now displayed as in Yorkshire; and, on the report of London drapers, it may be added, that the western manufacture still retains its ancient high character.

*Wool of British Cotton-grasses.*—Mr. Helliwell, of Todmorden, has manufactured a beautiful cotton russet cloth, and also yarn for stockings, from wool produced by the cotton-grass plants found upon his land. This plant, which grows on the highest and most useless land, consists of two kinds, the common or single-headed cotton-grass, *Eriophorum vaginatum;* and the narrow-leaved cotton-grass, or many-headed cotton-grass, *Eriophorum angustifolium*—both perennial plants. From the latter, the cloth and yarn were manufactured. On any common, even in its uncultivated state, there might be from two to three cwt. produced upon an acre, and the cost would not exceed 2*d.* to 3*d.* a pound. The cloth is remarkably firm and beautiful.

WORM CAKES.—In mucilage of gum-dragon mix 2 oz. of scammony, 3 oz. of calomel, 2 oz. of jalap, 4 oz. of cream of tartar, and 3 lbs. of white sugar.—*Or, (Herrenschwand's)* Mix 10 grs. of gamboge and 1 scruple of salt of tartar.

WORM LOZENGES, WORMCAKES, &c. consist always of calomel, scammony, jalap, gamboge, &c., often badly mixed; some are coloured with cinnabar.

WORMWOOD.—*See* ARTEMISIA.

WOUNDS, are divided, by writers on surgery, into several kinds. Hence we have *cuts* and *incisions*, which are produced by sharp-edged instruments, and are generally free from all contusion and laceration. The fibres and texture of the wounded part have suffered no other injury but their mere division; and there is, consequently, less tendency to inflammation, suppuration, and gangrene, than in other species of wounds. The surgeon has only to bring the opposite sides of the wound into contact with each other, and keep them in this state a few days, and they will unite and grow together.

Another class of wounds are *stabs*, or *punctured wounds*, made by bayonets, lances, swords, daggers, &c., and also by the forcible introduction of thorns, nails, &c. These wounds frequently penetrate to a great depth, so as to injure large blood-vessels, viscera, and other organs of importance. Bayonet-wounds, of the ordinary soft parts, are very often followed by violent inflammation, an alarming degree of tumefaction, large abscesses, fever, delirium, and other symptoms.

A third description of wounds are the *contused* and *lacerated*, which strictly comprehend, together with a variety of cases produced by the violent application of hard, blunt, obtuse bodies, to the soft parts, all those denominated *gunshot*-wounds. Wounds may, likewise, be universally referred to two other general classes, the simple and complicated. A wound is called *simple*, when it occurs in a healthy subject, has been produced by a clean, sharp-edged instrument, is unattended with any serious symptoms, and the only indication is to reunite the fresh-cut surfaces. A wound, on the contrary, is said to be *complicated*, whenever the state of the whole system, or of the wounded part, or wound itself, is such as to make it necessary for the surgeon to deviate from the plan of treatment requisite for a simple wound. The differences of complicated wounds are, hemorrhage, nervous symptoms, contusion, the unfavourable shape of the injury, the discharge or extravasation of certain fluids, indicating the injury of particular bowels, or vessels, &c.

All large or deep wounds are attended with more or less of symptomatic fever, which usually comes on at a period varying from sixteen to thirty-six hours after the infliction of the injury. It is of great consequence to attend to the type of this fever in the treatment; for the loss of blood, which may be required and sustained with impunity in the one species of fever, may prove most injurious, if not fatal, in the other. In all wounds, much depends on excluding the air by dressing, or protecting, with goldbeater's skin, &c. The air is the exciter of the inflammation, and, if excluded, and there is no foreign substance in the wound, its exclusion is always beneficial.

YARROW, (*milfoil*,) is astringent, tonic, and vulnerary, used in hæmorrhages; and, externally, in head-ache, tumours, &c. It is added to beer, to render it more intoxicating, and has been recommended to smokers, in lieu of tobacco.

YEAST, for a sack of flour, or 80 loaves, is made by stirring into a paste 6½ lbs. of flour, with 11 pints of boiling water. It should stand six hours, and a pint and a half of yeast be added. Place it in a warm place, and in six or seven hours it will be as good yeast for the batch as the best table-beer yeast.

Beer yeast, dried, may be kept for many weeks; and, mixed with water, produces good fermentation.

Sugar of starch ferments with water, and so does the juice of grapes, without yeast.

Yeast serves, by the fermentation of dough, to impregnate it with carbonic acid gas; and flour, kneaded with water and impregnated with carbonic acid gas, becomes as good bread as when made with yeast. Seltzer-water, used instead of common water, would effect the purpose. Yeast may also be superceded, by substituting, for the 4 oz. of salt, or muriate of soda, in a peck-loaf, first 10½ oz. of carbonate of soda, well kneaded, and add 1⅘ pints of muriatic acid (1·121) and knead quickly; the carbonic acid would be generated, and the bread rise as decidedly as with yeast. The expence is a prohibition, but the fact illustrates the principle. The fermentation of bread resembles all fermentation. The sugar of the wheat takes the vinous fermentation, and, the baking being a species of distillation, spirits are evolved, of which it is proposed, by the patent bread, to take advantage.

Yeast is added, for working malt liquor, from two to three pints to a barrel, as the weather is hot or cold.

13-15ths of yeast is water, and there are of volatile matters 1-5th in the remaining 2-15ths. Then, as *dry* yeast is as good a ferment as liquid yeast, nothing remains but extractive 2, mucilage 4, gluten 8, and saccharine 5, and the three first are passive. The power of yeast, then, is ascribed to a commenced fermentation of its saccharine part.

When the fermentation is too slow, worts are *roused*, that is, the head-yeast is beat so as to mix the whole thoroughly.

Yeast yields 13 potash, 15 carbonic acid, 10 acetic acid, 45 malic acid, 69 lime, 240 alcohol, 120 extractive, 240 mucilage, 315 saccharine matter, 480 gluten, and 13·6 water. It ferments any vegetable infusion containing saccharine matter, and evolves carbonic acid. It is a beneficial addition to a poultice for foul ulcers.

YELLOW BASILICON.—Mix 1 ℔. each of yellow rosin, bees'-wax, and Burgundy pitch, with 3 oz. of common turpentine, and 1 ℔. of olive-oil.

YEW, (*Taxus.*)—Wood very hard, thought to be poisonous, as were also the berries, but they may be eaten; leaves poisonous to cattle. Its pollen may be substituted for that of lycopodium.

YTTRIUM, is made from its oxide gadolinite, or yttria, like aluminum.

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ZAFFRE, is one part of roasted cobalt, ground with two or three parts of pure quartzose sand, and is used as a blue colour for painting on glass.

ZEDOARY, is an East Indian plant, called Acua, and by Linnæus curcuma. Its root nearly resembles camphor. It was formerly much extolled by physicians in female complaints, but is now used only as a carminative.

ZINC precipitates, as metals, the acid solutions of lead, tin, copper, mercury, silver, bismuth, and cadmium; but, it has no action on those of iron, nickel, manganese, cobalt, &c.

Zinc plate and leaf is very important in the pursuits of electricity and galvanism. In rolling it gets covered with oil, but this is easily removed by soap or alkali.

Zinc is of a bluish-white color, brighter than lead, of considerable hardness, and so malleable as not to be broken with the hammer, though incapable of much extension. But, at a temperature between 212° and 300° Fahr., it is both malleable and ductile. It may be granulated, like the malleable metals, by pouring it, when fused, into cold water; or, if it be heated nearly to melting, it is then sufficiently brittle to be pulverized. Its specific gravity is from 6·9 to 7·2.—It melts at about 700° Fahrenheit, and soon afterwards becomes red-hot, burning with a dazzling white flame of a bluish or yellowish tinge, and is oxidized with such rapidity *that it flies up in the form of white flowers, which are called flowers of zinc*, or *philosophical wool.* When zinc is burned in chlorine, a solid substance is formed, of a grayish-white color, semi-transparent, the *chloride of zinc*, and it may likewise be made by heating together zinc-filings and corrosive sublimate, and is soft as wax.

It has been called the *butter of zinc* and *muriate of zinc.*—The *ores of zinc* are five in number; viz. *blende*, *red-oxide of zinc*, *electric calamine*, *calamine*, and *white vitriol.*

Blende occurs in primitive and secondary rocks, and is found associated with galena and copper pyrites. It is the ore which affords the zinc of commerce. *Calamine* is found crystallized, and massive. It is more or less transparent, commonly of a grayish or yellowish-white color. Before the blow-pipe it is infusible, but loses about thirty-four per cent. by ignition, and it dissolves with effervescence in muriatic acid. It is highly prized, on account of the facility with which brass may be manufactured from it.

Zinc, rolled into large plates, is employed as a substitute for lead and slates, in the roofing of buildings. The great advantage of these plates of zinc is their lightness, being only about one-sixth part of the weight of lead. They do not rust, which is another great advantage, and has led to the employment of zinc-pipes both for cold and hot-water. No covering is better adapted for verandas and summer-houses.

FINIS.

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