is executed, by placing these lumps in sieves, on each of which is laid a disc of *lignum vitæ*. The sieves are made of parchment-skins, perforated with a multitude of round holes. Several such sieves are fixed in a frame, which by proper machinery has such a motion given to it as to make the *lignum vitæ* runner in each sieve move round with considerable velocity, so as to break the lumps of the cake, and force the substance through the sieves, forming grains of several sizes. These granular particles are afterwards separated from the finer dust, by proper sieves and reels. *Sixth*, The corned powder is next hardened, and the rougher edges taken off, by being revolved in a close reel or cask turning rapidly on its axis. This vessel somewhat resembles a barrel-churn; it should be only half full at each operation, and has frequently square bars inside, parallel to its axis, to aid the polish by attrition. *Seventh*, The gunpowder is now dried, which is done generally by a steam-chest, or by transmitting a body of air, slightly heated in another chamber over canvass shelves covered with the damp gunpowder.

GLUE.

Glue is an inspissated jelly, made from the parings of hides and other offals, by boiling them in water, straining through a wicker basket, suffering the impurities to subside, and then boiling it a second time. The articles should first be digested in lime-water, to cleanse them from grease and dirt; then steeped in water, stirring them well from time to time; and lastly, laid in a heap, to have the water pressed out before they are put into the boiler. Some recommend that the water should be kept as nearly as possible to a boiling heat, without suffering it to enter into ebullition. In this state it is poured into flat frames or moulds, then cut into square pieces when congealed, and afterwards dried in a coarse net. It is said to improve by age; and that glue is reckoned the best which swells considerably without dissolving by three or four days' infusion in cold water, and recovers its former dimensions and properties by drying. Shreds or parings of vellum, parchment, or white leather, make a clear and almost colourless glue.

INK.

Although Ink may be obtained of almost any colour, yet we are only familiar with two kinds, black and red. Of black ink there are three principal kinds, Indian ink, printers' ink, and writing ink.

Indian Ink.—This article is used in China for writing with a brush, and for painting upon the soft flexible paper of Chinese manufacture. It is ascertained, as well from experiment as from information, that the cakes of this ink are made of lampblack and size, or animal glue, with the addition of perfumes or other substances not essential to its quality as an ink. The fine soot from the flame of a lamp or candle, received by holding a plate over it, mixed with clean size from shreds of parchment or glove-leather not dyed, will make an ink equal to that imported.

Printers' Ink.—This is a black paint, smooth, uniform in its composition, and very tenacious. Linseed or nut oil are employed in its manufacture, and lampblack is the common material used for giving the black colour, of which two ounces and a half are sufficient for sixteen ounces of the oil, which must first be boiled down to the consistency of varnish. Vermilion gives a red colour. Ten or twelve gallons of the oil are set over the fire in an iron pot, capable of holding at least half as much more; for the oil swells up greatly, and its boiling over into the fire would be very dangerous. When it boils, it is kept stirring with an iron ladle; and if it do not itself take fire, it is kindled with a piece of flaming paper or wood; for simple boiling, without the actual accession of the oil, does not communicate a sufficient degree of the drying quality required. The oil is suffered to burn for half an hour or more, and the flame being then extinguished by covering the vessel close, the boiling is afterwards continued with a gentle heat, till the oil appears of a proper consistence; in which state it is called varnish. It is necessary to have two kinds of this varnish, a thicker and a thinner, from the greater or less boiling, to be occasionally mixed together as different purposes may require: that which answers well in hot weather being too thick in cold, and large characters not requiring so stiff an ink as small ones. The thickest varnish, when cold, may be drawn into threads like weak glue; by which criterion the workmen judge of the due boiling, small quantities being from time to time taken out and dropped upon a tile for this purpose. It is very viscid and tenacious, like the soft resinous juices, or thick turpentine. Neither water nor alcohol dissolve it; but it readily enough mingles with fresh oil, and unites with mucilagues into a mass diffusible in water in an emulsive form. Boiling with caustic alkali produces a soapy compound. It is by washing with hot soap-leys and a brush that the printers clean their types. The oil loses from one-tenth to one-eighth of its weight by the boiling into the thick varnish. It is affirmed that varnish containing either turpentine or litharge, particularly the latter, is more adhesive than other varnish, and presents a great difficulty in cleaning the types, which soon become clogged. Very old oil requires neither of these additions. New oil can hardly be brought into a proper state for drying, so as not to set off, without the use of turpentine.

Writing Ink.—The following is considered an excellent recipe for the manufacture of this useful liquid:—Take eight ounces of Aleppo galls (in coarse powder); four ounces of logwood (in thin chips); four ounces of sulphate of iron; three ounces of gum-arabic (in powder); one ounce of sulphate of copper; and one ounce of sugar-candy. Boil the galls and logwood together in twelve pounds of water for one hour, or till half the liquid has evaporated. Strain the decoction through a hair sieve or linen cloth, and then add the other ingredients. Stir the mixture till the whole is dissolved, more especially the gum; after which, leave it to subside for twenty-four hours; then decant the ink, and preserve it in bottles of glass or stoneware, well corked. Inks of other colours may be made from a strong decoction of the ingredients used in dyeing, mixed with a little alum and gum-arabic. For example, a strong decoction of Brazil wood, with as much alum as it can dissolve, and a little gum, forms a good red ink. These processes consist in forming a lake, and retarding its precipitation by the gum.

Sympathetic Inks.—These are inks by which any thing written with them may be invisible when first traced upon the paper, but can be rendered visible at will by certain means, such as the application of heat. Blank inks the most amusing experiments may be performed. Dr Ure mentions the following as amongst the number of those which a slight knowledge of chemistry may suggest to the student:—

"1. If a weak infusion of galls be used, the writing will be invisible till the paper be moistened with a weak solution of sulphate of iron; it then becomes black, because these ingredients form ink. 2. If paper be soaked in a weak infusion of galls, and dried, a pen dipped in the solution of sulphate of iron will write black on that paper, but colourless on any other paper. 3. The diluted solutions of gold and silver remain colourless upon the paper, till exposed to the sun's light, which gives a dark colour to the oxides, and renders them visible. 4. Most of the acids or saline solutions being diluted, and used to write with, become visible by heating before the fire, which concentrates them, and assists their action on the paper. 5. Diluted prussiate of potash affords blue letters when wetted with the solution of sulphate of iron. 6. The solution of cobalt in aqua regia, when diluted, affords an ink which becomes green when held to the fire, but disappears again when suffered to cool. This has been used in fanciful drawings of trees, the green leaves of which appear when warm, and vanish again by cold. If the heat be continued too long after the letters appear, it renders them permanent. 7. If oxide of cobalt be dissolved in acetic acid, and a little nitre added, the solution will exhibit a pale rose colour when heated, which disappears on cooling. 8. A solution of equal parts of sulphate of copper and muriate of ammonia, gives a yellow colour when heated, that disappears when cold. Sympathetic inks have been proposed as the instruments of secret correspondence; but they are of little use in this respect, because the properties change by a few days remaining on the paper; most of them have more or less of a tinge when thoroughly dry; and none of them resist the test of heating the paper till it begins to be scorched. Nitrate of silver for a surface impregnated with carbonate of soda, and muriate of gold for one impregnated with proto-muriate of tin, form good indelible inks."

FERMENTATION.

The word fermentation expresses the changes which animal and vegetable matter undergoes spontaneously when the principle of life has departed from it, or when its powers are suspended in individual parts. This is at once a process of destruction and of reproduction; for although there is not produced again a regularly organised structure, there is the production of new substance, different from that which characterised the organic body previous to the change taking place. The following case will serve to illustrate the nature of fermentation and its various stages:—If a quantity of grape juice be put into a vessel, and allowed to stand for some time, only exposed to the ordinary temperature of summer, the following phenomena will be observed: the liquor becomes muddy; an internal motion is observable, and sometimes the temperature may be found to rise; air bubbles rise to the surface, occasioning a bubbling noise when they break; and the bulk of the liquid being increased, it has a tendency to boil over. From this circumstance, the process is called fermentation, from the Latin word *fervere*, to boil. The bubbles created rise to the surface involved in a viscid matter, the whole resembling froth, which, parting with the air, subsides to the bottom, and the liquor becomes tranquil and transparent. This viscid matter is well known under the name of *yeast* or *barm*, and it has the property of exciting fermentation in bodies not otherwise at the moment predisposed to it. The reason of this has not been properly explained.

The grape juice has now been entirely changed into an intoxicating liquor, the base of which is alcohol, and this process is termed *vinous fermentation*. If this liquor be kept for some time at about 75°, a new series of phenomena will take place. Providing there be a large quantity of it, the temperature may perhaps rise fifteen degrees. A slight motion takes place, accompanied with the disengagement of a small quantity of gas; and floating filaments or shreds begin to thicken in the liquid, collecting into a gelatinous cake. This is indicative of another change. The vinous flavour and the alcoholic or intoxicating quality has disappeared, whilst the liquid has become at once sour and transparent. In short, the wine has become vinegar, called in Latin *acetum*; and the process is called the *acetous* fermentation.

Let this vinegar be kept for a length of time, and another, and from the previous quality of the liquor, unexpected, change takes place. It becomes mantled with a green mould; the acidity and pungent acid smell disappear, and a fœtid odour becomes perceptible. This proceeds from the rottenness of the vegetable matter present, and the change is called the *putrifactive* fermentation, from the Latin word *putrescere*, to rot. There are thus three different kinds of fermentation, which it may be necessary more fully to explain.

The question arises, What is the nature of the different ferments which produce these changes? The attention of chemists has as yet been particularly directed only to that one called *yeast*, and even our knowledge of it is extremely imperfect. Fabroni, a celebrated chemist, considered yeast as identical with *gluten*, a substance which imparts to wheaten flour the property of forming a tough paste with water, and separable from flour by kneading under water. This gluten, or some modification of it, the above-named chemist considered as the real *vinous* ferment. It is most probably an approximation to it; and it has been conjectured that *ferment* may be as much a proximate principle of vegetables, as sugar or starch, and as extensively diffused throughout nature. A great quantity of carbonic acid is given out during fermentation, and the various changes which take place during the vinous fermentation have been thus briefly described —Some of the carbon and some of the oxygen combine to form carbonic acid; while the remainder of the carbon, the remainder of the oxygen, and the whole of the hydrogen, combine to form alcohol; and we may totally neglect the decomposition of the yeast, it amounting to almost nothing. Thus is this inert, solid, fixed, sweet matter, resolved by a new arrangement of its principles into substances which possess none of these properties, and one of which exerts a control of so singular a nature over the animal economy.

The phenomena attendant upon acetous fermentation we have already alluded to, and the question occurs, What becomes of the alcohol, the most remarkable ingredient of the original vinous liquor, when the matter is changed into vinegar? In answer to this, all that can be said is, that it has been decomposed; its elemental particles, which, united in certain determinate or definite proportions, formed one particular kind of substance, have separated, and combined again in certain other definite proportions, by this means forming an entirely new substance. It is to be observed, that in every case where vinegar is formed, whether it be from solutions of sugar, infusions of malt, or from wines, the greater the quantity of alcohol which existed in the liquor, the stronger will be the vinegar obtained, and the more difficult and slow will be its formation. All vinegars prepared by fermentation contain the following ingredients:—A considerable quantity of water, a little alcohol, some malic acid, a small proportion of sugar, some gluttinous and mucilaginous matter, with what is vaguely called extractive matter, besides acetic acid.

The last stage of spontaneous decomposition is the putrifactive fermentation. It is that final change which animal and vegetable life undergoes, the resolution of organic structures into the inanimate materials of which they had been originally composed. The cause of the remarkable fœtor which accompanies it is not well understood, but it in part would appear to arise from the hydrogen gas given out, holding phosphorus and sulphur dissolved, which compounds are remarkably fœtid. It seems also partly to arise from some animal or vegetable matter, or some other substance being held in solution besides.

Upon the other and less important branches of practical chemistry, our limits prevent us from entering; but we have studied to give an account of such processes as can be easily comprehended by those who have carefully perused the number of this work upon Chemistry, and which are calculated to be most extensively useful.

THE END.

Edinburgh: Printed and Published by W. and R. Chambers, 19, Waterloo Place; and Orr and Smith, Paternoster Row, London.